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Amphibia Zambesiaca 4. Bufonidae

by

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ABSTRACT

A treatment is given of the taxonomy and distribution of bufonids occurring in Botswana, Caprivi, Zambia, Malaŵi, Mozambique and Zimbabwe. Genera included are *Bufo, Stephopaedes* and *Schismaderma.*

INTRODUCTION

During the past three decades, African bufonids have received a substantial amount of specialist attention. This has led to some instability in the taxonomy and nomenclature on account of several disagreements between authors. There are still many problems that need detailed attention, and this present treatment of Zambesiaca bufonids can aim to do little more than give a state-of-the-art review, giving as much prominence to problems as to apparent solutions.

Clarke (in press) has recently commented on the paucity of material of small-sized bufonid species in collections, even though individuals may emerge in large numbers in wet weather. The ranges of these species are, as a result, very imperfectly known, and much still needs to be discovered about their ecology and morphological variation. Particularly in the western and northern parts of the Zambesiaca area, several of the small-sized species are represented by very few, or only one, specimen, making it seem likely that other species occur there without being recorded. *Mertensophryne micranotis* is one such possibility, which, as Mertens (1955*b*) has noted, may be expected to occur at the same localities as his *Bufo lindneri* (see under this species). *M. micranotis* is at first sight similar to *B. taitanus*, but can immediately be distinguished by the much reduced web, and overall ventral darkening instead of the *taitanus* trident marking. *M. schmidti* (*B. ushoranus* of Schmidt & Inger 1959) could also be looked for in northwestern Zambia.

The subspecies category is retained in this Part: contrary to the assertion made by Tandy & Keith (1972) that ‘there is no conceptual basis for this taxonomic category’, there are, as noted in the Introduction to Part 1 of this series (Poynton & Broadley 1985*a*), conceptually clear situations where the subspecies category has been put to use in the southern African amphibian fauna, and where the category can be meaningfully and usefully retained. The nomenclatural advantage of using the subspecies category, noted by Poynton & Broadley (1985*a*), has

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however fallen away with modifications in the third edition of the *International Code of Zoological Nomenclature* (1985). It was implied in Poynton & Broadley (1985*a*) that the clustering of taxa on grounds of phylogenetic and biogeographical affinities could be reflected in the nomenclature only by adopting trinomials, a system based on the recognition of subspecies. Article 6(b) of the new Code allows, inter alia, a 'species-group' name to be added 'to denote an aggregate of species within a genus-group taxon'. The idea of a 'species-group' or 'super-species' has not been put to use in earlier parts of this study, however, and no advantage is seen in making any change in the grouping of taxa in the present Part. Particular application of the idea of subspecies is discussed under *Bufo fenoulheti grindleyi* and *Bufo gariepensis inyangae*.

In the Introduction to the section on the Ranidae (Poynton & Broadley 1985*b*), note was made of a trend involving 'the progressive splitting away of groups formerly treated at most as subgenera of *Rana*'. A similar trend is evident in the literature on *Bufo*, although it has developed more recently. Of the five 'subgeneric groups' recognised in southern Africa by Poynton (1964*a*), two which occur in the Zambesiaca area are now generally treated as separate genera, *Schismaderma* and *Stephopaedes*. Evidence that *Schismaderma* is distinct from *Bufo* continues to accumulate, and, on the basis of serum albumins, Maxson (1981:99) considers that 'the *Schismaderma* lineage has been independent of African *Bufo* since the Eocene'. Regarding *Stephopaedes anotis*, Poynton (1964*a*) noted that the life history was 'in particular need of investigation, as this last character might indicate more than subgeneric distinction'. After the discovery of the tadpole, Channing (1978) placed *anotis* in a separate genus on the grounds of the supposedly distinctive tadpole features, even though the tadpoles of African dwarf toads were very poorly known. The tadpole of *Mertensophryne micranotis* was subsequently described by Grandison (1980*a*), revealing strikingly close similarities with the *anotis* tadpole. A re-evaluation of the relationships of *anotis* is in progress, but, for the moment, *Stephopaedes* is retained at least to separate *anotis* from *Bufo*.

Dubois (1986) has placed *Schismaderma* and *Stephopaedes* into the same 'tribe', along with *Mertensophryne*. These genera are said to be distinguished 'par la présence d'une structure particulière sur le dessus de la tête et le dos du têtard' (p. 28). This grouping was done despite the admitted lack of evidence for homology between the fold in *Schismaderma* and the 'crown' in *Stephopaedes*. In fact the structures differ markedly: in *Stephopaedes* the 'crown' rings the eyes and nostrils (Channing 1978), while *Schismaderma* has a horseshoe-shaped fold extending from above the eyes to the trunk, and not enclosing the nostrils (Charter & MacMurray 1939). Dubois' grouping together of these three genera was evidently influenced by Grandison's (1981) discussion of a reduction in ossification of the squamosal in a '*vertebralis* group, which includes *Stephopaedes, Mertensophryne*, and possibly also *Schismaderma*' (p. 208–209). This gives no grounds for Dubois' conclusion that '*Mertensophryne, Stephopaedes* et *Schismaderma* consituent bien un groupe homophylétique' (p. 29): *Schismaderma* stands apart on egg size and number, tadpole structure and behaviour, and adult structures. In discussing the *vertebralis* condition of the squamosal, Grandison (in litt. 1978) noted that

S. carens 'seems to be the only large species that approaches the condition although it differs in other respects and has a few quite unique features'.

The value of currently recognising 'subgeneric groups' in Zambesiacan *Bufo* seems doubtful, in view of uncertainties and disagreements which prevail. Most small-sized species appear to cluster into a '*vertebralis* group' (including *f. fenoulheti*, *f. grindleyi*, *kavangensis* sp. n. and *beiranus*) and a '*taitanus* group' (including *taitanus*, *lonnbergi* and possibly *lindneri*), but this leaves out of account *urunguensis* and *melanopleura*, whose affinities still need clarification. The present treatment of the bufonids therefore follows the earlier parts of Amphibia Zambesiaca in being little involved with issues regarding supraspecific classification, it being considered that our knowledge is still too incomplete for such issues to be satisfactorily resolved. For practical purposes of identification and diagnosis, however, the *Bufo* species in the Zambesiaca area are here divided into two groups: members of the one group are relatively large-sized, possess a tarsal fold, and have all subarticular tubercles of the fingers and toes single; members of the other group are small-sized, lack a tarsal fold, and have at least some subarticular tubercles of the fingers and toes clearly doubled. Two somewhat different sets of characters are used in the species diagnoses of the two groups, and the descriptions given in the small-sized group are fuller on account of greater difficulties in the identification of the dwarf toads.

Literature references, locality grid references and acronyms for museum holdings which were given in earlier parts of this study are not repeated in this part (CAS—California Academy of Sciences is an additional collection). We have continued to benefit from unstinting help from museums in the United States, particularly from the American Museum of Natural History, Field Museum of Natural History, Museum of Comparative Zoology, and the U.S. National Museum. Dr Mills Tandy made available his identifications of large-sized species in the NMZB collection, and commented on a draft of this study. We have benefitted greatly from information, opinions and assistance given by Mr B. T. Clarke both while visiting the British Museum, and through correspondence; we have also had valuable discussions with Dr R. A. Stevens, whose dwarf bufonid material is included in this study. Discussions and correspondence over a lengthy period with Ms A. G. C. Grandison are warmly acknowledged. We have enjoyed the usual helpfulness given by Mr W. D. Haacke and Mrs L. Brown of the Transvaal Museum.

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SYSTEMATIC LIST

Species	*Recorded occurrence*						*Page*
	Botswana	*Caprivi*	*Zambia*	*Malaŵi*	*Mozambique*	*Zimbabwe*	
Genus *Bufo* Laurenti							
B. gutturalis Power	●	●	●	●	●	●	452
B. garmani Meek	●	●	●	—	●	●	455
B. kisoloensis Loveridge	—	—	—	●	—	—	459
B. maculatus Hallowell	●	—	●	●	●	●	460
B. fuliginatus Witte	—	—	●	—	—	—	463
B. lemairii Boulenger	●	—	●	—	—	—	464
B. gariepensis inyangae Poynton	—	—	—	—	—	●	464
B. f. fenoulheti Hewitt & Methuen	●	—	●	—	●	●	466
B. f. grindleyi Poynton	—	—	—	—	—	●	471
B. kavangensis sp. n.	●	—	—	—	—	●	472
B. beiranus Loveridge	—	—	●	—	●	—	476
B. urunguensis Loveridge	—	—	●	—	—	—	477
B. taitanus Peters	—	—	●	●	●	—	478
B. lonnbergi Andersson	—	—	●	●	—	—	479
B. lindneri Mertens	—	—	—	●	●	—	480
B. melanopleura Schmidt & Inger	—	—	●	—	—	—	481
Genus *Stephopaedes* Channing							
S. anotis (Boulenger)	—	—	—	—	●	●	483
Genus *Schismaderma* Smith							
S. carens (Smith)	●	●	●	●	●	●	484

KEY TO THE ZAMBESIACA BUFONIDAE

Caution: It is not possible to make reliable identifications on the basis of this key alone. The user is advised to check all the characters listed in the diagnoses and descriptions provided.

1 Tarsal fold present, subarticular tubercles of digits single, at most bifid, not clearly double 2

— Tarsal fold absent, at least some subarticular tubercles of digits clearly double 9

2 Parotid glands present, even if obscured by warts and spines 3

— No parotid glands, instead, a lateral glandular ridge running from above tympanum to near leg insertion .... **Schismaderma carens** (p. 484)

3 Dorsal markings highly asymmetrical, pupillary umbraculum present **B. gariepensis inyangae** 464)

— Dorsal markings in the main composed of paired darker patches, no pupillary umbraculum 4

4 Parotid glands flattened and without distinct margins, further obscured by warts .... **B. maculatus** (p. 460)
— Parotid glands prominent, raised well above the general surface and with distinct margins 5

5 Parotid glands continue posteriorly into a pair of glandular ridges running to sacral region .... **B. lemairii** (p. 464)
— Parotid glands not continuing posteriorly beyond scapular region 6

6 At least one row or ridge of whitish glands running along the length of undersurface of forearm 7
— No row or ridge of whitish glands running along the length of the undersurface of the forearm .... **B. fuliginatus** (p. 463)

7 Glands under forearm arranged in at least one row of discrete tubercles .. 8
— Glands in the form of a largely continuous ridge ...... **B. garmani** (p. 455)

8 Tibia length/body length (snout-urostyle tip) less than 41 % **B. kisoloensis** (p. 459)
— Tibia length/body length more than 41 % .... **B. gutturalis** (p. 452)

9 Tympanum discernible beneath skin 10
— Tympanum not discernible beneath skin 14

10 Outer margin of parotid glands distinct and straight 11
— Outer margin of parotid glands not distinct, or if distinct, curving downwards behind posterior margin of tympanum 12

11 A light vertebral line present, no ventral markings **B. kavangensis** (p. 472)
— No light vertebral line, ventral markings present .. **B. urunguensis** (p. 477)

12 No ventral markings .... **B. f. fenoulheti** (p. 466)
— Dark ventral markings present 13

13 Skin of snout and throat not, or only slightly, granular **B. f. grindleyi** (p. 471)
— Skin of snout and throat densely covered with spinules **B. beiranus** (p. 476)

14 Markings over pectoral area in the form of a bold trident **B. taitanus** (p. 478)
— Ventral markings, if present, not forming a trident pattern in the pectoral region 15

15 Outer margin of parotid gland markedly curving downwards behind otic region 16
— Outer margin of parotid gland more or less straight, not curving markedly behind otic region 17

16 Margin of parotid gland dipping ventrally to level of upper jaw, planed lateral and dorsal surfaces of gland set nearly at right angles to each other **Stephopaedes anotis** (p. 483)
— Ventralmost margin of parotid gland not passing below level of eye, not with clearly planed lateral and dorsal surfaces set at an angle (surface rounded) **B. lindneri** (p. 480)

17 Very small-sized species, snout-urostyle length not more than 27 mm **B. melanopleura** (p. 481)

— Medium-sized species, reaching length of 44 mm and becoming sexually mature by about 25 mm .... **B. lonnbergi** (p. 479)

Genus *Bufo* Laurenti

Bufo Laurenti, 1768: 25. Type by designation of Tschudi 1838: *Bufo vulgaris* Laurenti, 1768 (= *Rana bufo* Linnaeus, 1758).

Toads. Cosmopolitan apart from the Mascarene Islands, New Guinea, Australia and adjacent islands, Antarctica and the Arctic regions. Fifty-four species listed in Frost (1985) as occurring in Subsaharan Africa.

Bufo gutturalis Power

Bufo regularis gutturalis Power, 1927: 416. Lobatse and Kuruman. Syntypes in the McGregor Museum, Kimberley. Hewitt 1935: 292.

Bufo regularis ngamiensis FitzSimons, 1932: 40. Motlhatlogo, Botswana. Holotype in the Transvaal Museum, Pretoria. FitzSimons 1935: 381.

Bufo regularis (not Reuss); Boulenger 1907*b*: 4, Parker 1930: 905, Poynton 1964*a*: 51 & 1964*b*: 197 & 1966: 15, Stewart & Wilson 1966: 297, Stewart 1967: 27, Broadley 1971: 108, Stevens 1974: 5.

Bufo regularis regularis (not Reuss); Loveridge 1933: 354 & 1953*a*: 338 (part) & 1953*b*: 145; Pitman 1934: 310 (part).

Bufo ngamiensis FitzSimons, Poynton 1964*a*: 55, Tandy & Keith 1972: 159.

Bufo gutturalis Power, Tandy & Keith 1972: 159, Simbotwe & Patterson 1983: 21.

Diagnosis. Female adult size reaching 98 mm. Tarsal fold present, subarticular tubercles of fingers single (even if bifurcated to some extent), tympanum clearly discernible. Glands under forearm usually forming two conspicuous rows of whitish tubercles, not fused to form continuous ridge. Glands behind angle of jaw well developed, forming broken or unbroken ridge running to above axilla. Parotid glands prominent, not warty or spinose (at least typically: see under *B. maculatus*). Two phalanges of toes 3 and 5 free of main webbing, although distinct margin reaching the terminal phalanx is usually present.

Description. Large-sized toads, males attaining sexual maturity at length of about 50 mm. Canthal markings encroaching over snout to form pair of dark markings which extend onto anterior region of eyelids. Pair of dark orbital bars commence over more posterior region of eyelids, and often approach each other middorsally. Area between dark canthal and orbital markings forms conspicuous light interorbital bar, intersected by narrower light sagittal band. Thin, light vertebral line usually runs from urostyle to occipital region or onto snout. Red to scarlet patches occasionally developed on back of thighs and inguinal region of both sexes. Light dorsal freckling or spotting occurs on individuals from all parts of range.

Chest and abdomen of adults immaculate, but in males gular region suffused with black and yellow pigment (the latter tending to disappear in alcohol). Juveniles, especially in Malaŵi, may show ventral speckling.

Habitat. The species is common in moist savanna areas, and it also occurs in evergreen forests. Individuals find shelter under rocks and logs, down crab holes and other crevices; fairly concealed calling sites are preferred, but calling can occur in exposed situations. Breeding takes place usually in bodies of shallow, permanent water.

Remarks. B. ngamiensis FitzSimons was provisionally regarded as a distinct species by Poynton (1964*a*). It was noted that the skull of the holotype is unusually expanded; such expansion has not subsequently appeared as a feature in other material from Botswana, and the *ngamiensis* holotype need therefore no longer be considered to represent a possibly discrete species. Comparison of the holotype with presently available material from Botswana shows it to agree most closely with *gutturalis* in the shortness of the tibia (35 % snout-urostyle distance), and the rows of clearly separated tubercles under the forearm, although the alignment of the tubercles in rows is somewhat irregular.

Five NMZB specimens from Chavuma in western Zambia (1322 B1) have been identified by Tandy as *B. xeros* Tandy et al. In the description of *B. xeros*, Tandy et al (1976) state that while the call of this species is distinctive, no morphological character is known to separate it from *B. gutturalis*. *B. gutturalis* is said 'usually' to exhibit a more contrasting patterning; but on the other hand, it is common for toad species to show weakly contrasting markings where they occur on Kalahari Sand, and the Chavuma series could well be *gutturalis* specimens exhibiting this tendency. *B. xeros* is currently recorded as extending from west and central Africa south to southern Tanzania (Songea). The species may occur in Angola (Tandy et al. 1976). It may well occur in the Zambesiaca area, but in the absence of positive identifications based on calling, we are inclined to list the Chavuma material as *gutturalis*. Particular attention should however be given to calls of large-sized toads in Zambia and Mozambique.

Distribution. From Transkei, Lesotho, northern Cape Province (South Africa) and northern Namibia northwards through savannas to Uganda and Kenya.

Localities. BOTSWANA. Batubaja (TM), Boteti River (NMZB), Chiefs Island (TM), Chobe Swamp (NMZB), Four Rivers Camp (NMZB), Gomare & 24 km NE (NMZB), Kanye (NMZB), Kasane (NMZB), Khwai River (NMZB), Kwando River (TM), Lake Ngami (BM, TM), Lake Xau (NMZB), Lobatse (AM, MM), Maun (NMZB, TM), Moremi Reserve, 16 km SE of South Gate (TM), Motlhatlogo (TM), Nokaneng (TM), Pompom (NMZB), Shakawe (NMZB, TM), Sepopa (NMZB, TM), Thamalakane River (TM), Toteng (TM), Tshisan (TM), Xaxaba (NMZB), Xhenga Island (TM), Xugana (NMZB). CAPRIVI. Kabulabula (TM), Katima Mulilo (TM), Lake Liambezi (NMZB), Old Sangwali (TM). ZAMBIA. Balmoral Farm (NMZB), Balovale Dist. (13°32'S:22°40'E) (NMZB), Chavuma (NMZB), Chikowa (NMZB), Chilavi (BM), Chinsala (BM), Chinzombo (NM), Chipangali (NMZB), Chipata (NMZB), 16 km W Chisamba (AJL), Chongola (BM), Chundwaponda = Chiundaponde (BM), Chunga Camp (NMZB), Ikelenge (NMZB), Kalabo (NMZB), Kalenga (NMZB), Kalomo (BM, NMZB, NMZL), Kasusu (NMZB), Kataula (BM), Kazungula (NMZB), Livingstone (NMZB, NMZL), Luembwe/Luangwa (NMZB), Lundazi/Wasira (NMZB), 8 km E Lusaka (BM), Lusangazi (NMZB), Maiyumba (BM), Manga (NMZL), Mavumbi = Mfumbi (BM), Mazabuka (NMZB), Mbala (BM, PEM), Mfuwe (NMZB), Mkanda (NMZB), Monze (NMZL), Moshi (NMZB), Mpika (BM), Mpulungu (BM, PEM), Munkwi ? = Mkewe (BM), Mwekera (NMZB), Nchanga (BM), Ndola (NMZB), Ngoma

(NMZB), Niamkolo (MCZ), Nyimba (NMZB), Petauke Old Boma (NMZB), Sayiri Court (NMZB), Sesheke (NMZL), Siantamba (NMZB), Solwezi (NMZB), Victoria Falls (MM). MALAŴI. Blantyre Mission (BM), Chitipa (BM), Chikwawa (TM), Cape Maclear (NMZB), Kabotola (NMZB), Kondowe/Karonga (BM), Lifupa (NMZB), Lilongwe (NMZB), Limbe (NMZB), Limphasa Dambo (NMZB), Lujeri (NMZB), Misuku Hills (NMZB), Monkey Bay (BM), Mulanje Mountain (NMZB), Mulosa (JV), Ngara (NMZB), Nkhata Bay (BM, NMZB), Nyika Plateau (BM, NMZB), Ruo Gorge (JV), Thyolo Mountain (NMZB), Zomba (BM), Zomba Plateau (NMZB). Blantyre; Chitipa; Mzimba; Rumpi (Stewart 1967). MOZAMBIQUE. Amatongas (BM, NMZB), Beira (BM, DM, NM, NMZB), 13 km NE Beira (NMZB), Bela Vista (DM), Boror (NMZB), Charre (BM), Chemba (NMZB), Chimanimani Mountains (NMZB), Chimonzo (DM, TM), Chinizuia District (NMZB), Coguno (BM), 20 km S Erego (NMZB), Estatuane & 6 km S (NMZB), Garuso (NMZB), Gorongoza Mountain (NMZB), Inhaca Island (NMZB, TM), Inhambane (DM), 10 km W Inhassoro (NMZB), Macrera River (NMZB), Macuti (NMZB), Maforga (NMZB), Manga (NMZB), Massinga (NMZB), Mavita (NMZB), Mitucué Mountain (NMZB), Moamba (TM), Morrumbala Mountain (NMZB), Muandzane (NMZB), Muda/Lamego (NMZB), Nabaunama Dam (NMZB), Namaacha (DM, NMZB), Nhamanene Lake (NMZB), Nova Sofala (NMZB), Panda (DM), Pico Meponduine (NMZB), Pongola River Bridge (NM), Ponta de Ouro (TM), Vila de Manica (NMZB), Xiluvo (NMZB), Zavora (NMZB). ZIMBABWE. Arcturus (NMZB), Atlantica E.R.S. (AJL), Bangala Dam (NMZB), Banti F.R. (NMZB), Bikita (NMZB), Bracken Hills Dam (AJL), Buffalo Range (NMZB), Bulawayo (NMZB), Butler North (NMZB), Cashel (NMZB), Chikore (NMZB), Chimanimani Mountains (NMZB), Chinhoyi (NMZB), Chinyamanda (NMZB), Chiredzi (NMZB), Chirinda Forest (NMZB), Chupangu (NMZB), Criterion Mine (NMZB), Danangombe Ruins (NMZB), Darwendale (NMZB), Dasura River (AJL), Dombashawa Hill (AJL), Dunblane (NMZB), Engwa (NMZB), Erin F.R. (NMZB), Ewanrigg (NMZB), Figtree (NMZB), Gleneagles (NMZB), Gulati C.L. (NMZB), Harare (AJL, NMZB), Haroni-Rusitu Confluence (NMZB), Hayfield 'B' (NMZB), Holdenby C.L. (NMZB), Hopefountain (NMZB), Hunyani (TM), Karoi (NMZB), Kazungula & 10 km SE (NMZB), Kutama Mission (AJL), Kwekwe (NMZB), Kyle Lake (NMZB), Linslade Farm (NMZB), Lundi River (NM), Maleme Dam (NMZB), Mare Dam (AJL, NMZB), Marondera (NMZB), Masvingo (NMZB), Melfort (NMZB), Mgwalaati Farm (AJL), Mhangura (NMZB), Miami (NMZB), Miware Grove (NMZB), Mount Darwin (NMZB), Mount Hampden (NMZB), Mount Selinda (NMZB), Mutare (NMZB), 15 km NE Mutoko (NMZB), Myocun Farm (NMZB), Nyamakurwe River (NMZB), Ngezi Dam (NMZB), Ngorima C.L. (NMZB), Nuza (NMZB), Nyahodi River (NMZB), Nyakanga Bridge (NMZB), Nyanga C.L. (NMZB), Nyanyana River Mouth (AJL), Odzani (NMZB), Outward Bound School, Chimanimani (NMZB), 5 km E Penhalonga (NMZB), Piriviri River (NMZB), Pungwe Gorge (NMZB), Rhodes Estate Orchards, Nyanga (NMZB), Rhodes Estate Prep. School, Matopos (AJL), Rugare (NMZB), St Mary's Mission (NMZB), Sanyati River Mouth (AJL), Selborne (NMZB), Sengwa Gorge (NMZB), Shinda (NMZB), Silverstreams (NMZB), 20 km ENE Sipolilo (NMZB), Sote Source (NMZB), Stapleford F.R. (NMZB), Tandaai (NMZB), Troutbeck (NMZB), Turk Mine (NMZB), Umfuli River Bridge (AJL), Van Niekerk Ruins (NMZB), 30 km WSW Victoria Falls (NMZB), Vumba Mountain (NMZB), Watsomba (NMZB), 7 km E Wedza (NMZB), Westwood Vlei (NMZB), Zambezi/Chewore Confluence (NMZB), Zewa (NMZB).

Bufo garmani Meek

Bufo garmani Meek, 1897: 176. 'Haili', ie Halleh, Somalia. Syntypes in the Chicago Natural History Museum and the Museum of Comparative Zoology, Harvard. Poynton 1964*a*: 55 & 1964*b*: 198, Broadley 1971: 110, Tandy & Keith 1972: 141–146, 159, Simbotwe & Patterson 1983: 21.
Bufo regularis (not Reuss); Boulenger 1907*a*: 479. Power 1926: 777 & 1927: 416.
Bufo regularis regularis (not Reuss); FitzSimons 1935: 380.
? *Bufo pseudogarmani* Hulselmans, 1969. Goanikontes, Namibia. Holotype in the Senckenberg Museum, Frankfurt.

Diagnosis. Female adult size reaching 99 mm. Tarsal fold present, subarticular tubercles of fingers single (even if bifurcated to some extent), tympanum clearly discernible. Glands under forearm flattened, forming more or less continuous whitish ridge. Broken glandular ridge running from angle of jaw to above axilla. Parotid glands prominent, not warty. Two to (rarely) 2,5 phalanges of toes 3 and 5 free of main webbing, (see Remarks), although distinct margin reaching the terminal phalanges is usually present.

Description. Large-sized toads, males attaining sexual maturity at length of about 50 mm. Dark canthal patches nearly always present, not or only just encroaching onto snout, leaving area anterior to the pair of dark orbital bars largely light-coloured, occasionally with one or more small asymmetrically placed dark patches. Orbital bars not meeting middorsally. More posterior dark markings usually very well defined, but sometimes ground colour is so dark that markings are obscured. Markings usually outlined by pronounced and almost continuous dark line, interior of each marking being brown to red-brown, and frequently lightening to ground colour at centre. Red infusions occasionally present on back of thighs.

Chest and abdomen immaculate, but gular region in males suffused with black pigment.

Habitat. This toad is common in the drier savanna areas, often breeding in fairly open, ephemeral pans. It does not show a strong inclination to conceal itself when calling and mating.

Remarks. Namibian material that had formerly been referred to *garmani* by Poynton (1964*a*) was described as a new species, *pseudogarmani*, by Hulselmans (1969) on the grounds of several external features which were held to be distinctive. A series from Botswana was also included in the new species. Channing (1972) examined large series from two localities in Namibia, and demonstrated a range of variation which he took to invalidate Hulselmans's diagnosis of *pseudogarmani*. However, Botswana material sent to Hulselmans by the Transvaal Museum was sorted by him into 24 *pseudogarmani* from Ngamiland, 9 *garmani* from southeastern Botswana, and 4 'intermediates' from Caprivi; and one of us (J.C.P.) on re-examining the material, has found the adults, apart from the 'intermediates', to be readily divisible on a combination of at least some of the characters that were stated by Hulselmans (1969) to separate *pseudogarmani* from *garmani*, notably the length of the fourth toe (foot length 35–40 % body length in the Botswana *pseudogarmani*, 41–44 % in *garmani*) and the state of the plantar tubercles (smaller, more numerous and not arranged in rows in *pseudogarmani*). In the case of the 'intermediates', the foot length was 37–42 % the body length.

Material from the southeastern lowlands of the Zambesiaca area proves to be less amenable to such sorting, as is shown by the largest single-locality collections available from the region:

Marhumbini (including Machinawa Pan) (2132 A4). 9 specimens: NMZB 17632, 17653, 17674, 17745–6, 19556–9. (Identified as 'intermediate between *garmani* and *pseudogarmani*' by Hulselmans, in litt.) Foot length 39–42 % body length ('intermediate'), palmar tubercles small and scattered (*pseudogarmani*) to larger and fairly well aligned (closer to *garmani*), but the specimen showing the most *garmani*-like arrangement has the shortest, *pseudogarmani*-like feet. Markings are of the *pseudogarmani* type; webbing ranges between the two, the broad web being level with the middle tubercle of toe 3 (*pseudogarmani*) to falling well short of it (*garmani*). Parotid glands (to be discussed below) are *garmani*-like in one of the specimens with the shortest (*pseudogarmani*) feet, but *pseudogarmani*-like in most specimens.

Zavora (2435 C1). 9 specimens: NMZB 28478–9, TM 36605–11. Foot length 41–45 % body length (*garmani*); palmar tubercles small and scattered (*pseudogarmani*); markings mainly of *pseudogarmani* type; webbing variable. Parotid glands of *pseudogarmani* type.

Maputo (2532 D3). 6 specimens: NM 1798–1801, TM 7995 & 39894. Foot length 41–44 % body length (*garmani*); palmar tubercles small and scattered (*pseudogarmani*); markings mainly *garmani* type; webbing variable. Parotid glands of *pseudogarmani* type.

Ndumu Reserve, Natal (2632 C3 & C4). 7 specimens: NM 1798–1801, 1802, 6519–20. Foot length 37–42 % body length ('intermediate'); palmar tubercles small and scattered (*pseudogarmani*); both *garmani* and *pseudogarmani* type markings (but not correlated with foot length); webbing variable. Parotid glands of *pseudogarmani* type.

It is evident from these collections that an attempt to follow Hulselmans's separation of *pseudogarmani* from *garmani* would simply make the material from this southeastern lowland region unidentifiable. In contrast, the situation in the northern parts of the Zambesiaca area appears to be relatively unproblematic, at least to the extent that the material from Zambia is fairly readily assignable to *garmani* as here understood, even though a few supernumerary plantar tubercles or marked asymmetry of dorsal patches are shown by occasional specimens, such as one specimen NMZB-VJW 1241 in a series of nine from Lusangazi (1331 B3), a specimen which also has abbreviated parotid glands that fall short of the eyelids. Evidently a tendency is present in Zambian populations to produce '*pseudogarmani* features' even in areas which are distant from the main *pseudogarmani* concentration. The apparent absence of this species from Malaŵi, northern Mozambique and the Beira area seems inexplicable, but this absence does not seem to relate directly to any taxonomic problem. Typical *garmani* has been collected from the Tete area of central Mozambique and from the northern parts of Zimbabwe, also from more southern parts, but in the south, *pseudogarmani* features make an appearance, both in the form of blending (intermediate characters) and of independent assortment (even to the extent of specimens showing the *garmani* arrangement of tubercles on the one palm, and the *pseudogarmani* arrangement on the other, as in NMZB 3621 & 3652 from the Lupane district, 1872 D4).

An attempt to handle the nomenclature of southern material must include a clarification of the situation south of the Zambesiaca area. In South African collections, it is common to find foot/body length ratios which occupy the same range as the Botswana 'intermediates' of Hulselmans; yet a virtually invariable feature of the southern material is a scattering of small, densely set palmar tubercles, which is a feature of *pseudogarmani*, even in those specimens which are long-toed, a feature attributed to *garmani*. Eastern Transvaal lowland material provides an exception in tending to have large, well-aligned palmar tubercles, which fit Hulselmans's diagnosis of *garmani*, but the toes are short, mostly falling within the *pseudogarmani* range. Apart from such exceptions, South African material shows features which can be contrasted with 'typical' Zambian *garmani* as follows: a larger body size, reaching a length of over 90 mm (rarely over 75 mm in *garmani*); smaller, more numerous and densely scattered palmar tubercles (larger, fewer, arranged in rows in *garmani*); shorter fourth toe (see above, but this is a particularly inconsistent feature); and fuller webbing, the broad web tending to be level with or even passing the distal tubercle of the third toe (in *garmani*, usually falling short of this tubercle, occasionally just reaching its proximal edge). The markings in *pseudogarmani* are typically less clearly demarcated and coarser, and less symmetrical over the back, as illustrated by Hulselmans (1969 fig. 2). The anterior portion of the parotid gland is enlarged in *garmani*, so that it abuts onto the eyelid and the tympanum; in southern Zambesiacan material the parotid gland is often not so extensive, not making contact with the eyelid and tympanum, and in South African material this becomes the usual condition.

It has to be noted that this set of features shown by South African material includes Hewitt's *poweri* (1935) from Kimberley in the northern Cape. A case therefore exists for relegating *pseudogarmani* to the synonymy of *poweri*. Details in markings could however be used to argue against this, such as the shape of the pair of dark patches lying between the anterior region of the parotid glands. They are rounded in Hulselmans's illustration (1969, fig. 2) of *pseudogarmani* (as is usual in *garmani*), but they tend to be elongated in material from the northern Cape. This elongation becomes even more marked in more eastern material, and the variation could be clinal. The question of synonymy between *pseudogarmani* and *poweri* has to rest on a much more comprehensive analysis of South African and Namibian material than is presently available, and it seems inappropriate for this study of the Zambesiaca region to embark on such an analysis. It is unclear whether '*poweri*/*pseudogarmani*' characters show sufficient stabilisation in South Africa for recognition to be given to one or more taxa which can be distinguished from the *garmani-pseudogarmani* 'intermediates' of Botswana or from the indeterminate eastern lowland material. As a result, it is unclear whether the 'intermediate' or indeterminate material represents hybrid populations, or whether it is indicative of complex peripheral differentiation which is not attributable simply to hybridisation with yet more southerly taxa. For the moment, therefore, all the Zambesiacan material is assigned to *garmani*. The possibility of there being at least two taxa is however accommodated in the list of localities by starring those localities from which one or more specimens have been collected that show any *poweri*/*pseudogarmani* features. This evaluation has to be imprecise, since there is no clear line of demarcation between what may be considered 'pure' *garmani* and what is not. Where only doubtful *poweri*/*pseudogarmani* features occur at a locality, the locality is indicated by ?*.

Distribution. From northern Natal, northern Orange Free State, northern Cape, Botswana and northern Namibia northwards through savannas to Somalia, but apparently with disjunctions: not recorded from the Beira area, northern Mozambique and Malawi. *Schismaderma carens* is another large-sized toad avoiding the Beira-Lower Zambezi area.

Localities. Localities have been marked with an asterisk if any specimen has been collected there which shows any *poweri*/*pseudogarmani* features (see Remarks). Where such features are only doubtfully shown, the locality is indicated by ?*. An asterisk against a locality does not imply that *only* *poweri*/*pseudogarmani*-type material has been collected there; nor is it implied that the absence of an asterisk against a locality means that specimens bearing *poweri*/*pseudogarmani* features will not be found there in the future. BOTSWANA. *Crocodile Camp (TM), *Four Rivers Camp (NMZB), Francistown (MM, NMZB), Gaborone (NMZB, TM), ?*10 km W Gaborone (NMZB), *Gomare (NMZB), *Kabulabula (NMZB, TM), *Kanye (NMZB), Kgwebe Hills (TM), *Khumaga (NMZB), *Lake Ngami (FMNH), *Lake Xau (NMZB), *Maun (NMZB), *Maxwee (NMZB), Metsemotlhaba River (TM), Motlhatlogo (TM), 5 km S Nata (NMZB), *10 km S Nata (NMZB), *Nokaneng (TM), Nywane Dam (NMZB), Pont Drift (TM), *Sehitwa (NMZB, TM), *Sekoma Pan (NMZB), Sequane (NMZB), *Shakawe (NMZB, TM), ?*Shashi-Simukwe Confluence (NMZB), *Sukwane (NMZB), Tsau (TM), *Thamalakane River (TM), *Toromoja (NMZB), *Toteng (NMZB), *Tsau (TM), *Tselenyane Pan (NMZB). CAPRIVI. Katima Mulilo (TM), *Old Sangwali (TM). ZAMBIA. Chikowa (NMZB), Chipangali (NMZB), Dinde Thicket, Chipepo (BM), Kalichero (NMZB), Katete/Lupande (NMZB), Lundazi/Wasira (NMZB), Lusangazi (NMZB), Mazabuka (NMZB), Mkanda (NMZB), Monze (NMZL), Nyimba (NMZB), Petauke Old Boma (NMZB), Sesheke (NMZL), Sitwe (NMZB). MOZAMBIQUE. *Alves de Lima (NMZB), *Boane (TM), *Chigubo (TM), *Chimonzo (TM), Chinamainza (NMZB), *Estatuane & 6 km E & 10 km SSE (NMZB), *5 km E Jungamo (TM), Magasso (NMZB), *15 km SW Magude (TM), *Maputo (NM, TM), *Masiene (TM), *Massangena (NMZB, TM), *Matchova (NMZB), Moamba (TM), ?*Muandzane (NMZB), 19 km SW Mungari (NMZB), *Nhamanene Lake (NMZB), *Panzila (NMZB), *Pico Mepunduine (NMZB), *Ponta Chemucane (TM), *10 km SSE Ressano Garcia (NMZB), Tete (NM), *Zavora (NMZB, TM), *Zinave (NMZB). ZIMBABWE.

Antelope (NM, NMZB), Battlefields (MM), Beitbridge (DM, NMZB), Bembezi (NMZB), Beverley Hills (AJL), *Birchenough Bridge (NMZB, TM), Bulawayo & 25 km NNW (NMZB), Bumi Mouth (NMZB), Cement (NMZB), 16 km SSW Chakari (AJL), *Changadzi Bridge (NMZB), Charara Mouth (NMZB), Chikombedzi (NMZB), *Chilonga (NMZB), Chimburu Mouth (NMZB), Chimwara Ranch (NMZB), Chinhoyi (NMZB, TM), *Chipinda Pools (NMZB), Chiredzi (NMZB), Chirinda Forest (BM), ?*Chivirira Falls (NMZB), Chomuravati (NMZB), Doddieburn Ranch (NMZB), Fishan (NMZB), *Gem Farm (AJL), Gokwe (TM), *48 km N Gokwe 1728D4 (TM), Gokwe/Sanyati C.H.A. (NMZB), Gweru (NMZB), Guluene South (NMZB), Harare (BM, NMZB), Hazelside (NMZB), Heany (NMZB), Hwange (NMZB), Hwange N.P. (NMZB), Inyati C.L. (NMZB), Kadoma (AJL), Kaitano (NMZB), 5 km SW Kamativi (NMZB), Kapami (NMZB), Kariba (NMZB), 20 km NNE Kariba (AJL), Kwekwe & 15 km ESE (AJL), Longueville Ranch (NMZB), Lower Nuanetsi River (NMZB), Lukosi (NMZB), Lundi River Bridge (NM), *Lupane (NMZB), *10 & 15 km NW Lupane (NMZB), ?* Mabalauta F.S. (NMZB), *Machinawa Pan (NMZB), Mahenya (NMZB), Main Camp, Hwange N.P. (NMZB), Majinji Pan (NMZB), Malapati Drift (NMZB), Maleme Dam (NMZB), *Malugwe Pan (NMZB), Mana Pools (NMZB), *Marhumbini (NMZB), Masvingo (AJL), Mazowe (BM), 5 km NNW Mazunga (NMZB), Mount Darwin (AJL), Mpakati (NMZB), Muchesu Firebreak (NMZB), Mutare (NMZB), Nottingham Ranch (NMZB), Ntambambomvu Hills (NMZB), Nyahungwe (NMZB), Nyakadese Dam (NMZB), Nyamandhlovu & 15 km WSW (NMZB), Nyanyana River Mouth (AJL), Pachanza (NMZB), Razi Dam (NMZB), Rukomeshe R.S. (NMZB), Rupisi Hot Springs (NMZB), Sabi/Lundi Confluence (NMZB), Samalema Gorge (NMZB), Sengwa Gorge (NMZB), Sentinel (NMZB), Shashi Irrigation Scheme (NMZB), Shashi/Shashani Confluence (NMZB), Sililabuhwa (NMZB), Sinamatela Camp (NMZB), *Siyanje (NMZB), Thomson Junction (NMZB), *Triangle (NMZB), Tshabezi Bridge (NMZB), Tuli Safari Area (NMZB), Tsungwesi River (NMZB), West Sebungwe (NMZB), Westwood Vlei (NMZB), Zambesi-Chewore Confluence (NMZB).

Bufo kisoloensis Loveridge

Bufo kisoloensis Loveridge, 1932: 52. Kisolo, southwestern Uganda. Holotype in the Chicago Natural History Museum.

Bufo garmani (not Meek); Poynton 1964*b*: 198 (part: Mugesse Forest, Misuku Mountains), Stewart 1967: 32, Tandy & Keith 1972: 141–146, 159.

Diagnosis (based partly on extralimital material). Female adult size reaching 85 mm. Tarsal fold present, subarticular tubercles of fingers single, tympanum clearly discernible. Glands under forearm forming at least one row of well separated, conical tubercles. Glands or warty tubercles sometimes forming broken glandular ridge from angle of jaw to above axilla. Parotid glands prominent, sometimes with covering of minute spines. Less than two phalanges of toes 3 and 5 free of main webbing (sometimes only one phalanx of toe 5 free), and well-developed margin reaches the terminal phalanges.

Description. Fairly large-sized toads, males attaining sexual maturity at length of about 50 mm. Canthal markings absent to only weakly developed, markings on snout absent to fairly well developed and forming a pair of patches encroaching onto anterior portion of upper eyelids. Light interorbital bar may be absent to conspicuous. Pair of dark orbital patches or bars commence over more posterior region of eyelids and may approach each other very closely middorsally (but do not fuse broadly as portrayed in Stewart 1967 Fig. 8). Thin, light vertebral line usually runs from urostyle to occipital region or onto snout.

Habitat. Restricted to cool, moist montane forests.

Remarks. The Malaŵi record is based on two juveniles collected by Stewart, both of which lack the light interorbital bar usually present in *kisoloensis*; but there is at least a trace of a small dark patch on the anterior end of the eyelid, which falls within the range of variation of *kisoloensis*, but not of *garmani*, with which the specimens were initially confused. More material is needed to confirm the present identity of the Malaŵian specimens. A poorly preserved specimen from the Nyika Plateau (BMNH 97.6.9.231), noted by Stewart (1967) as being possibly conspecific, has two phalanges of toes 3 and 5 free of web, even of web margin, which excludes it from *kisoloensis*. It appears to be a specimen of *gutturalis*.

Distribution. Highland areas of Uganda, Rwanda, Congo Republic, Zaire, Kenya and northern Malaŵi.

Locality. MALAŴI. Mugesse Forest (NMZB, USNM).

Bufo maculatus Hallowell

Bufo maculatus Hallowell, 1854: 101. Liberia. Types unknown, probably lost.
Bufo angusticeps (not Smith); Peters 1882: 179.
Bufo regularis regularis (not Reuss); Loveridge 1933: 355 (part) & 1953*a*: 338 (part).
Bufo regularis pusillus Mertens, 1937: 17. Letaba Camp, Kruger National Park, South Africa. Holotype in the Senckenberg Museum, Frankfurt.
Bufo pusillus Mertens, Poynton 1964*a*: 53 & 1964*b*: 198 & 1966: 15, Stewart & Wilson 1966: 298, Stewart 1967: 30, Broadley 1971: 108.
Bufo maculatus pusillus Mertens, Stevens 1974: 5.

Diagnosis. Female adult size reaching 65 mm. Tarsal fold present, subarticular tubercles of fingers single, tympanum clearly discernible. Glands under forearm forming at least one conspicuous row of white tubercles, not fused to form a continuous ridge. Glands behind angle of jaw well developed, forming broken ridge. Parotid glands flattened, indistinct and covered by dark-tipped warts. Two to slightly less phalanges of toes 3 and 5 free of main webbing, although a margin reaching terminal phalanx is sometimes present.

Description. Medium-sized toads, males attaining sexual maturity at length of about 40 mm. Canthal markings encroaching onto snout to form pair of dark markings which extend over anterior region of eyelids. Pair of dark orbital bars commence over more posterior region of eyelids, and approach each other closely middorsally. Area between dark canthal and orbital markings forms conspicuous light interorbital bar. Light vertebral line running from snout to urostyle usually present.

Chest and abdomen immaculate to speckled, speckling being usually more dense in juveniles. Gular and pectoral region in males suffused with black and yellow pigment.

Habitat. This is a common savanna species, often sympatric with *B. gutturalis* and/or *B. garmani.* Breeding can occur in open country, but preferred calling sites are those concealed by rocks or vegetation.

Remarks. B. pusillus was placed in the synonymy of *maculatus* by Tandy & Keith (1972) with indications of uncertainty, on the grounds of very similar morphology and mating calls. This synonymy has become established in the southern African literature largely through its acceptance in Passmore & Carruthers (1979), the similarity in calling being taken as a weighty consideration. Contra-indications were however presented by Low (1972) and by Guttman (1972) on the basis of comparisons of parotid gland secretions and blood proteins. These contra-indications have been reinforced by immunological evidence, which led Maxson (1981) to conclude that the gene pools of *pusillus* and *maculatus* have been isolated for some five to six million years.

This positive biochemical evidence for taxonomic separation could be held to outweigh the evidence based on calling and morphology, but the sampling of material for biochemical data is far too meagre to give any indication of where the geographical boundary lies between the two possible forms—if in fact there is indeed a clearly defined phenetic and geographical boundary. In the present uncertain situation, the principle of least disturbance of the nomenclature has to be conformed with, and the current practice of placing *pusillus* in the synonymy of *maculatus* is here followed. Hulselmans's (1970) proposal of treating *pusillus* as a subspecies of *maculatus* seems to have no value at the present time when critical phenetic and geographical data are lacking.

In external features, *maculatus* very closely resembles *B. gutturalis.* The condition of the parotid glands is customarily taken to be the chief diagnosing character, but in some specimens these glands may be flattened yet not clearly covered by dark-tipped spines, a situation which does not allow ready assignment either to *maculatus* or to *gutturalis.* A few specimens cannot, in the preserved condition, be identified with confidence on the basis of any external features currently used as 'characters'.

Distribution. Subsaharan savannas south to northern Natal, eastern and northern Transvaal, northern Botswana and northern Namibia.

Localities. BOTSWANA. Four Rivers Camp (NMZB). ZAMBIA. Chilavi (BM), Chipangali (NMZB), Chipata (NMZB), Chisamba Falls (NMZB), Chiwale (BM), Chiwanda (BM), Chundwapande = Chuindaponde (BM), Chunga Camp (NMZB), Ikomba (MCZ), Kalabo (NMZB), Kalikali (NMZB), Kalikali/Kongwe (NMZB), Kalimba (BM), Kasempa (AMNH), Kasusu (NMZB), Katete/Lupande (NMZB), Livingstone (BM, NMZL), Luembwe/Luangwa (NMZB), Lundazi/Wasira (NMZB), Lusangazi (NMZB), Mambwe (PEM), Mbala (PEM), Mfuwe (NMZB), Mkanda (NMZB), Mpulungu (PEM), Mwana (BM), Nkana (MM), Nyimba (NMZB), Petauke Old Boma (NMZB), Sasare (NMZB), Sayiri Court (NMZB), Siantambo (NMZB), Sitwe (NMZB), Zungwala (BM). MALAŴI. Cape Maclear (NMZB), Chikwawa (TM), Chiromo (NMB), Kasungu (BM), Lifupa (BM), Lilongwe (NMZB), Limbe (NMZB), Makoka A.R.S. (BM), Mulanje Mountain (TM), Mzimba (NMZB), Nashua (BM), Ngara (NMZB), Nkhata Bay (NMZB), Wamkurumadzi Bridge (NMZB), Zomba Mountain (BM). Misuku Hills; Mzimba; Nchenachena; Nkhata Bay; Rumpi; Zomba (Stewart 1967). MOZAMBIQUE. Alves de Lima (NMZB), Amatongas (NMZB), 20 km N Beira (TM), Chapala (NMZB), Chemezi (NMZB), Chibabava (NMZB), Chiniziua (NMZB), Chiuta (TM), Dondo (NMZB), 8 & 10 km NW & 15 km NNW Dondo (NMZB), Dondo Forest (NMZB, TM), 19 km S Erego (NMZB), Espungabera (NMZB), Garuso (NMZB), Gondola/Gorongoza Pontoon (NMZB), Goonda (NMZB), Gorongoza Mountain (NMZB), Grudja (NMZB), Gumba (NMZB), Inchope (NMZB), Jorge (NMZB), Lower Revue Bridge (NMZB), Maforga (NMZB), Makurupini Valley (NMZB), Manga (NMZB), Massangena (NMZB, TM), Mazamba (TM), Metambanhe (NMZB), Mitucué Mountain (NMZB), Moamba (TM), 14 km S Muanza (NMZB), Muda (NMZB), Nabaunama Dam (NMZB), Namaacha (DM, NMZB), Ponte do Calichane (NM), Revue Bridge (NMZB), Tete (TM, ZMB), 5 km E Tete (NMZB), Tôa River (NMZB), 13 km SE & 10 km SSE Vila Gouveia (NMZB), Vila de Manica (NMZB), 25 km SW Vila Pery (NMZB), 10 km SW Zobue (NMZB). ZIMBABWE. Atlantica E.R.S. (AJL), Bikita (NMZB), Binga C.L. (NMZB), Birchenough Bridge (NMZB), Cashel (NMZB), Cassava (NMZB), Chegutu (AJL), Chido (NMZB), Chikombedzi (NMZB), Chikore (NMZB), Chimanimani Mountains (West) (NM), Chimwara Ranch (NMZB), Chinyika C.L. (NMZB), Chipinda Pools (NMZB), Chipinge (NMZB), Chiredzi (NMZB), Chirisa Safari Area (NMZB), Chivake River Bridge (NMZB), Chiwaka Bridge (NMZB), Chizarira N.P. (NMZB), Corfe Farm (AJL), Danangombe Ruins (NMZB), Darwendale (NMZB), Darwendale Dam (AJL), Doddieburn Ranch (NMZB), Eldorado (NMZB), Esigodini (NMZB), Falcon College (AJL), Foliot Farm (NMZB), Fothergill Island (AJL), Great Zimbabwe Ruins (NMZB), Gungunyana F.R. (NMZB), Harare (AJL, NMZB), Harleigh Ruins (NMZB), Haroni-Lusitu Confluence (NMZB), Hazelside (West) (NMZB), Holdenby C.L. (NMZB), Hwange (NMZB), Inyazura (NMZB), Kapami (NMZB), Kariba (AJL, NMZB), 20 km NNE Kariba (AJL), Karoi (NMZB), Katombora Rapids (NMZB), Kazungula (NMZB), Kyle Lake (AJL), Kwekwe (NMZB), Lemoenfontein (NMZB), Le Rhone (NMZB), Longueville Ranch (NMZB), Lower Mtrazi River (NMZB), Lundi River Bridge (NM), Lupane (NMZB), Lusulu (NMZB), Maleme Dam (NMZB), 15 km S Malimbasimbi (NMZB), Mambwe Pass (NMZB), Mana Pools (NMZB), Maori Ranch (AJL), Marhumbeni (NMZB), Maryland (NMZB), Matetsi River Bridge (NMZB), Matopos (NMZB), Matusadona N.P. (NMZB), Mazoe (BM), Melfort (NMZB), Merrywaters (NMZB), Mhangura (NMZB), Mrewa (NMZB), Mubagwashe (NMZB), Mutare (NM, NMZB), Mutoko (NM, NMZB), 15 km NE Mutoko (NMZB), Mwenda Estuary (NMZB), Myocun Farm (NMZB), Nalatale Ruins (NMZB), Namakurwe River (NMZB), Ngezi Dam (AJL), Ngorima C.L. (NMZB), Nyakadese Dam (NMZB), Nyamakari (NMZB), Nyanga (NMZB), Odzi (NMZB), Old Umtali (NMZB), Pounsley (NMZB), Ranelia (NMZB), Razi Dam (NMZB), Redcliff (AJL), Ridgemount (AJL), Ruenya River Drift (NMZB), Runde C.L. (NMZB), Rupisi Hot Springs (NMZB), Ruwa (NMZB), Ruware (NMZB), Ruyurukuru River (NMZB), Sabi Drift (NMZB), Sabi/Lundi Confluence

(NMZB), Sabi Star (NMZB), St Faiths Mission (NMZB), Sangala Dam (NMZB), Sanyati Island (NMZB), Sanyati River Mouth (AJL), Sengwa Gorge (NMZB), Shashi Irrigation Scheme (NMZB), Sibilobilo Lagoon (AJL), Sililabuhwa (NMZB), Silverstreams (NMZB), Sipolilo & 20 km ESE (NMZB), Somabula (NMZB), Sote Source (NMZB), Stapleford (NMZB), Toghwana Dam (NMZB), Togwe W.A. (NMZB), Triangle (NMZB), Tuli (NMZB), Umfuli River (AJL), Umvumvumvu River (NMZB), Valhalla (NMZB), Victoria Falls (NMZB), Vumba Mountain (AJL, NMZB), Watsomba (NMZB), Whitewaters (NMZB), Zambezi/Matetsi Confluence (NMZB), Zewa (NMZB), Zona (NMZB).

Bufo fuliginatus Witte

Bufo fuliginatus Witte, 1932: 1. Lukafu, Zaïre. Holotype in the Musée Royal de l'Afrique Centrale, Tervuren.

Diagnosis. Female adult size reaching 65 mm. Tarsal fold present, subarticular tubercles of fingers single, tympanum discernible, but tympanic ring tending to be covered by spinose warts. Glands under forearm forming two not very conspicuous rows of dark-tipped tubercles. No, or only a very broken line of glands running from angle of jaw to above axilla. Parotid glands prominent, covered by dark-tipped spines except in males in full breeding condition (see Schmidt & Inger 1959 as *B. funereus upembae*). Less than two phalanges of toes 3 and 5 free of main webbing, margin of web reaching almost to tips of toes.

Description (based partly on extralimital material: only one specimen is known from Zambia). Medium-sized toads, males attaining sexual maturity at length of about 40 mm. Markings not clearly developed, but paired dark orbital stripes and canthal patches encroaching onto snout can be discerned, leaving poorly defined lighter interorbital area. Skin of body, and especially limbs, particularly spinose, although less so in breeding males.

Ventral surface without distinct markings, but skin suffused with dark pigment. Gular skin of males not darker (evidently related to absence of vocal sacs in this form).

Habitat. Forest.

Remarks. Laurent (1964) briefly discussed *fuliginatus* as a 'race' of *funereus* Bocage. He believed *fuliginatus* to have been redescribed under the name of *upembae* by Schmidt & Inger (1959). The material from the Upemba Park and from Zambia differs from more northern Zaïrean material, currently assigned to *funereus*, in possessing a well-developed tarsal fold, which extends the length of the tarsus, in the slightly reduced webbing, and in the faintness of dorsal markings. There is also more encroachment of warty tissue over the tympanum than in *funereus*. The features do, however, show variation in *funereus*: the tarsal fold, for example, may be completely lacking to distinctly developed along the distal portion of the tarsus (marked variation may even be shown on the two legs of the same individual). The status of *fuliginatus*, therefore, does need investigating by, as Laurent (1964) suggests, a study of populations from areas between the presently accepted ranges of *fuliginatus* (Zambia and southern Zaïre) and *funereus* (northern Zaïre, northern Angola and forested areas north to Uganda and West

Africa). Until data from this region accumulate, no value is seen in treating *fuliginatus* as a subspecies of *funereus*, as was done by Hulselmans (1970), and *fuliginatus* is here treated provisionally as a separate species.

Distribution. Southern Zaïre and northern Zambia.

Locality. ZAMBIA. Mambwe (PEM).

Bufo lemairii Boulenger

Bufo lemairii Boulenger, 1901: 1. Pweto, southern Zaïre. Type not traced. Broadley 1971: 110, Haacke 1982: 11.
Bufo lemairei Boulenger, Pitman 1934: 310.

Diagnosis. Female adult size reaching 70 mm. Tarsal fold present, subarticular tubercles of fingers single, tympanum clearly discernible. Glands under forearm flattened, forming more or less continuous whitish ridge. Prominent glandular ridge running from angle of jaw to above axilla, and glandular pad present on upper arm. Parotid glands prominent, not warty, each continuing posteriorly into glandular ridge which reaches sacral area. More than two phalanges of toes 3 and 5 free of main webbing, although margin of web runs to base of last phalanx.

Description. Fairly large toads with a *Rana*-like appearance, produced by relatively narrow head, large tympana, and long toes. Width of head 60 % to 70 % length of foot, horizontal diameter of tympanum subequal to horizontal diameter of eye. Males attain sexual maturity at length of about 50 mm, as far as is known from relatively limited material. Pair of dark orbital bars present, not meeting middorsally, and pair of markings on snout, which may expand onto upper eyelid, demarcating light interorbital bar. This patterning tends to fade to overall yellowish colour in adult males. Light vertebral line present, which tends to fade in adults. Both sexes in breeding condition may have extensive red infusions on upper surface of thighs and flanks.

Ventral surface immaculate.

Habitat. Pitman (1934) noted: 'In mid-May found in hundreds of thousands in an extensive swamp on the fringe of the flats east of the Bangweulu swamps . . . near the village of Marbo.' Haacke (1982) reported on material taken on the flood plains bordering the Okavango Delta.

Distribution. Northern Botswana, through western Zambia and eastern Angola to southern Zaïre.

Localities. BOTSWANA. Four Rivers Camp (NMZB), Shakawe (NMZB), Xugana (TM, USNM). ZAMBIA. Bombwe Marsh (BM, TM), Kalabo (FMNH, NMZB), Lukona Mission (FMNH), Mayau River (AMNH), Sesheke (NMZL). Marbo (Pitman 1934).

Bufo gariepensis inyangae Poynton

Bufo gariepensis inyangae Poynton, 1963: 319. Inyangani Mountain, Zimbabwe. Holotype in the Natural History Museum of Zimbabwe, Bulawayo. Poynton 1964*a*: 48.
Bufo inyangae Poynton, Martin 1972: 62, Tandy & Keith 1972: 158.

Diagnosis. Female adult size reaching 49 mm. Tarsal fold present as weak ridge, but tending to be barely evident in well-hydrated specimens, subarticular tubercles of fingers single (sometimes bifid), tympanum clearly discernible. Small white tubercles under forearm not arranged into definite rows. Very irregular, broken line of glands present from angle of jaw to above axilla. Parotid glands prominent, not warty. More than two and a half phalanges of toe 3 and two of toe 5 free of main webbing, last two phalanges free of all but trace of a margin of web.

Description. Fairly small-sized toads, males reaching length of 41 mm and attaining sexual maturity at length of about 30 mm. Irregular, very asymmetrical dark markings present on dorsal surface, parotid glands tending to be picked out by absence or limited encroachment of dark markings. Small pupillary umbraculum present.

Ventral surface immaculate to heavily flecked.

Males in breeding condition with cornified spines on the dorsal surface of body and limbs; females with no, or less cornified, spines. Male vocal sac shows variation in degree of darkening, and may not be discernible through skin even in specimens with a strong development of asperities on upper and inner surfaces of inner finger and on inner metacarpal tubercle.

Habitat. The type series was collected under stones near the summit of Inyangani Mountain (2 560 m). A long series from Rukotso (2 400 m), on the top of the western escarpment at the northern end of the Nyanga Mountains, was taken in grassland with exposures of bare granite: the toads were hiding under stones or down rodent burrows.

Remarks. Martin (1972) compared skulls of *B. g. gariepensis*, *g. inyangae* and *Capensibufo rosei*, and suggested specific status for *inyangae* on account of osteological 'differences in size and proportion' from *g. gariepensis*. He believed that '*B. rosei* appears most closely related to *B. inyangae*'. Grandison's 1980*b* work on *rosei*, which led to its separation into *Capensibufo*, had not commenced at that time; but Martin's conclusions do not allow much confidence in the taxonomic value of the characters he studied. Low (1972) found very close chromatographic affinity between *g. gariepensis* and *g. inyangae*.

It is regrettable that Martin did not examine material of *B. g. nubicolus* from the eastern highlands of South Africa, which, externally, differs hardly at all from the eastern highlands material of Zimbabwe. Both *nubicolus* and *inyangae* appear to be eastern montane differentiations of *gariepensis*; but while the range of *nubicolus* still fuses with that of *gariepensis*, *inyangae* is isolated, although it appears that this isolation is relatively recent, since *gariepensis* shows evidence of substantial range contraction even within historical times (Poynton 1964*a*). Following the procedure adopted in this study, discussed in the Introduction, the evident kinship of these three taxa is reflected in the nomenclature by retaining subspecific status for *inyangae*, despite the present geographical gap: distributional features by themselves are, as Dupuis (1984) has pointed out, not to be regarded as taxonomic 'characters', and therefore should have no bearing on nomenclature.

Distribution. Nyanga Mountains of Zimbabwe.

Localities. ZIMBABWE. Chirwa/Garesi Ridge (NMZB), Nyanga (NMZB), 10 km ENE Nyanga (AJL), Inyangani (NMZB), Inyangombi headwaters (NMZB), Pungwe Gorge (NMZB), Rhodes Nyanga National Park (BM, NMZB), Rukotso (NMZB), Worlds View, Nyanga (NMZB).

Bufo fenoulheti fenoulheti Hewitt & Methuen

Bufo fenoulheti Hewitt & Methuen, 1913: 108. Newington and Woodbush, Transvaal, South Africa. Holotype (from Newington) in the Port Elizabeth Museum. Hewitt 1932: 110.
Bufo fenoulheti obtusum Hewitt, 1925: 363. Bleskop, Rustenburg district, Transvaal. Holotype in the Transvaal Museum, Pretoria. FitzSimons 1935: 382.
Bufo vertebralis albiventris Power, 1927: 418. Lobatse, Botswana. Syntypes in the McGregor Museum, Kimberley. FitzSimons 1935: 382.
Bufo fenoulheti rhodesianus Hewitt, 1932: 110. Driefontein, Zimbabwe. Holotype in the Port Elizabeth Museum.
Bufo vertebralis fenoulheti Hewitt & Methuen, Poynton 1964*a*: 63, Broadley 1971: 110.

Diagnosis. Female adult size reaching 35 mm (exceptionally up to 40 mm). No tarsal fold, subarticular tubercles of fingers usually double, tympanum discernible. Parotid gland (when distinct) bulging ventrally behind tympanum, forming a strongly curved outline. Two to 2,5 phalanges of toes 3 and 5 free of web (edge of web may be slightly serrated, making determination somewhat imprecise), broad web between toes 3 and 4 not, to only just, passing base of proximal phalanx of fourth toe. Two enlarged palmar tubercles present, but inner much smaller and may be only slightly larger than other palmar tubercles.

Description. (Some variation shown in eastern material reviewed under *f. grindleyi*.) Small-sized toads, males reaching length of 35 mm, maturing at about 24 mm; females reaching length of 40 mm, becoming gravid below length of 30 mm. Tympanum distinct in adults, less so in juveniles; vertical diameter equal or (more usually) subequal to internarial distance. Parotid glands flattened, margins not always clearly discernible, separated from upper eyelids by narrow groove or gap of up to two warts. Outer margin, when discernible, tending to follow edge of tympanum usually to half-way around its posterior border (less frequently to more than half-way); width of backward continuation of gland about 0,65 to 0,75 maximum anterior width, often obscured by warts. Subarticular tubercles of fingers and toes usually double, but may be single (although no individual has only single tubercles). Two to (rarely) 2,75 phalanges of third toe free of web on outer surface, edge of web not, to only slightly, serrated.

Abdominal skin of males and females a pavement of very flattened warts, sometimes surmounted by minute spines (more commonly so in females). Pectoral and gular skin of females similar to abdominal skin; in males, warts on pectoral and gular skin are more conspicuous, forming 'the finest dust-like granulation' (Hewitt 1932). Skin of back with fairly prominent warts, each wart surmounted by central spine which, in larger warts, is surrounded by ring of smaller spines. Degree of development of warts and especially spines variable, with some geographical variation (see Remarks). Top of head without warts except where they may form bases of scattering of single spines, some 30 to 60 in number in more northern material, but tending to be less numerous in material from southern Botswana and South Africa (see Remarks). Undersurface of digits fairly smooth, only a few supernumerary tubercles present.

Dorsal markings: light markings show wide range of variation in intensity and extent. Variation at least to a degree substrate-related: light markings can be nearly or completely lacking, especially in sandy areas; but particularly in granite areas, light markings tend to be exaggerated, providing strong contrast with dark patches and so producing camouflage that makes specimens extemely difficult to detect when resting on granite. Throughout range, there is usually at least a conspicuous, more or less round occipital patch (usually linked on either side to somewhat duller stripe running obliquely over each eyelid), and on either side of body a light patch between arm insertion and parotid gland in region where gland narrows. This lateral pair may be made more conspicuous by being raised by glandular tissue. Light patch, or pair of patches, commonly present in sacral area, and there may be a connection between this and the light occipital patch, made by light vertebral stripe. Sacral patch may be extensive, forming broad transverse band. Vertebral stripe may continue posteriorly over urostyle, and may intersect with transverse light bar positioned just anterior to region of leg insertion. Snout area usually lighter, but any such light marking normally separated from occipital patch by dark interocular bar.

Dark markings consist mostly of paired patches, apart from single interocular bar, normally continuous from one eyelid to other. This bar often continues posteriorly as bifurcated markings, forming anterior border of light occipital patch, and on either side of occipital patch a rounded dark patch. Pair of elongated dark patches lie behind occipital patch; these markings lie close together and are often connected by a suture. Occasionally area between this pair conspicuously lightened, recalling pattern of *B. vertebralis*.

Ventral surface usually immaculate, rarely with irregularly placed dark spots or flecks, mostly in midline of pectoral region. Sometimes also a more or less complete dark line curving down in front of insertion of arm, very occasionally approaching midventral markings, giving suggestion of trident pattern in *f. grindleyi*. Gular skin of male immaculate (yellow in life), but dark vocal sac beneath it shows through skin.

Sexual dimorphism: males in breeding condition may be recognised externally by yellow gular skin and dark vocal sac beneath, by more granular and looser gular skin, smoother abdominal skin, and by minute asperities on upper and inner surfaces of first and second fingers and inner palmar tubercle.

Habitat. The species may occur in sandy areas, but it tends to be strongly associated with rocky outcrops, finding concealment under stones and rock slabs. Breeding takes place in pools, often of a temporary nature.

Remarks. Small-sized toads collected from the southwestern border of Zambia, through Zimbabwe, southern Mozambique (excluding the Beira area) and the Transvaal to northern Natal and southeastern Botswana, all appear to be referable to a single taxon. This material was grouped as *B. vertebralis fenoulheti* by Poynton (1964*a*), along with *B. fenoulheti damaranus* Mertens of Namibia, a form to be discussed later. The placing of *fenoulheti* as a subspecies of *vertebralis* Smith was influenced by the inclusion of Power's *v. albiventris* (from Lobatse, southeastern Botswana) in the synonymy of *fenoulheti*. Power (1927) considered his Lobatse material 'to be between *vertebralis* and *fenoulheti obtusum*' (p. 419), and placed it 'as a subspecies of the former' without giving any reason for the choice. A specimen believed to be of *vertebralis* from 'Madibi', which had 'but a few small black spots ventrally', seems to have influenced Power's opinion and led him to suspect that *vertebralis* and his Lobatse form intergraded in the 'Madibi' area ('Madibi' appears to be an alternative name for Madiba, some 20 km southwest of Mafikeng). The call of the Lobatse population was, however, stated to be 'entirely different from that of *vertebralis*' (p. 420).

Poynton (1964*a*) considered Power's *v. albiventris* to fall within the range of variation shown by *fenoulheti* (including *f. obtusum* from Rustenburg in the western Transvaal), but he still retained Power's concept of subspecific relationship with *vertebralis* by treating *fenoulheti* as a subspecies of *vertebralis*. More recent collecting of *vertebralis* in the Orange Free State, and a checking of localities by De Waal (1980), makes it seem unlikely that *vertebralis* occurs north of 28°S in the Free State. Distribution in the northern Cape Province still requires clarification, but it no longer seems justified to follow Power in assuming that intergrading between *vertebralis* and *fenoulheti* occurs. The difference in call noted by Power between *albiventris* and *vertebralis* appears to agree with a difference in call indicated between Transvaal *fenoulheti* (Passmore & Carruthers 1979:80) and Cape *vertebralis* (Tandy & Tandy 1976, Fig. 2B). All the available evidence therefore suggests treating *fenoulheti* as specifically distinct from *vertebralis*.

Poynton (1964*a*) placed *fenoulheti damaranus* Mertens in the synonymy of '*vertebralis fenoulheti*', which met with Mertens's (1971) briefly argued disagreement on grounds of distribution, development of tympanum and markings. Mertens considered *damaranus* and *fenoulheti* to have a subspecific relationship, one which he believed was shared with *dombensis* Bocage, but not with *vertebralis*. This view resulted in his combination: *Bufo dombensis fenoulheti*. In deciding whether or not Mertens's procedure should be followed, the situation regarding dwarf toads in Namibia and southern Angola has to be reviewed, to the extent permitted by the limited material available. The massive lumping by Tandy & Keith (1972) of the forms which will be considered here into '*Bufo dombensis*' also calls for such a review. Our conception of the species and subspecies categories has been discussed in the Introduction to Part 1 of this series (Poynton & Broadley 1985*a*) and in the Introduction to this Part.

In Namibia there appear to be at least four taxa of dwarf toads recognisable on external features. One taxon evidently includes material from Runtu on the Okavango River which was initially identified by Mertens (1955*a*) as *B. regularis*, and subsequently placed by him (1971)—with misgivings—in *damaranus*. This taxon appears to be distributed widely in the Okavango region, and it will be described below as *B. kavangensis*. Still in northern Namibia, material has been collected northwards from Outjo and the Brandberg which was referred to *dombensis* Bocage by Poynton (1964*a*), an assignation accepted by Mertens (1971) and confirmed by Grandison (pers. comm.). Material in the Windhoek Museum from Spitzkoppe, further south, is also referable to *dombensis*. Most of the available material has been directly compared with two BM syntypes of *dombensis*. Leading features of this material are a very clearly shown tympanum, a lack of spines on the very smooth dorsal surface of the head, and a lack, or only very poor development, of a dark interorbital bar: when this bar is lacking or incomplete, the light occipital patch becomes characteristically continuous with a light patch on the top of the head.

The third Namibian taxon is represented by material from the Kaokoveld-Waterberg area, which was named *damaranus* by Mertens. This material differs from *dombensis* in tending to possess a concealed tympanum, in having spines —some 5 to 30—on the top of the head, and having markings which are somewhat different: they are not very distinct, and there are no prominent light patches, but among the dark markings a relatively dark interorbital bar is usually discernible, which, as noted above, is not a feature of *dombensis*. The limited material available does however present variation that makes the assignation of some specimens either to *damaranus* or to *dombensis* problematic. The tympanum tends to be less discernible in juveniles than in adults, and the degree of spinosity is by no means fixed: for example a single specimen in the Windhoek Museum from the Cunene Mouth has the relatively large tympanum of *dombensis*, but the spinosity of *damaranus*. Interocular markings in this specimen are of the very reduced *dombensis* type. A series of eight *damaranus* topotypes in the BM shows variation from a very distinct to a virtually obscured tympanum, with some variation in head spinosity. Mertens's listing of *damaranus* as *B. dombensis damaranus* could therefore be taken to be justified: on the other hand, extensive sympatry could be indicated by several specimens collected from the Kaokoveld south to the Brandberg, all of which can be separated either into *dombensis* or into *damaranus*. Clearly the matter needs further investigation.

It seems to be more definite that intergradation cannot be proposed as a means to justify Mertens's combination: *dombensis fenoulheti*. Mertens suggested that the Runtu material, here included in *kavangensis* sp. n., could indicate 'einen Ubergang' between *damaranus* and *fenoulheti*, but *damaranus* differs from *kavangensis* notably in lacking the very granular structure of the ventral skin, in having a curved (not straight) outer margin to the parotid gland, and in the lack of a light vertebral line. These differences do not bridge any gap between *damaranus* and *fenoulheti*, while *damaranus* differs further from *fenoulheti* in lacking the light patches of *fenoulheti*, in the weaker development of dorsal spines, and in the tendency for the tympanum to be more obscured (although, as noted by Poynton 1964*a*, this is not a constant feature).

The fourth possibly recognisable taxon in Namibia includes all dwarf toads collected south of the range of *damaranus*, referred to *hoeschi* Ahl and to *jordani* Parker. Parker's *jordani*, based on a single specimen from near the southernmost limit of the currently known range, was said to have a completely reduced auditory apparatus. Grandison (in litt. 1978) re-examined the *jordani* specimen and found the middle ear apparatus to be present, a condition which one of us (J.C.P.) has confirmed. A tympanic ring and columella is also present in four TM specimens collected west and southwest of the *jordani* type locality (Farms Hoeacht and Duwisib). The eustachian tubes, said by Parker (1936) to be absent in *jordani*, tend to be occluded in this southern material, but the pharyngeal openings are visible if mucus and shed epithelium are scraped away. While usually showing bold light dorsal patches similar to *fenoulheti* (which may be expanded to produce light coloration over more of the dorsum), *hoeschi* differs from *fenoulheti* and resembles *dombensis* in the smooth skin of the snout and throat. Some differences between *hoeschi* and *damaranus* were discussed by Mertens (1971), who treated *hoeschi* as a full species on the grounds of virtual sympatry with *damaranus*. The situation regarding *hoeschi* and *dombensis* still however needs clarification: there seems in fact to be very little in the way of constant features to separate the two taxa as currently recognised, and the reduced visibility of the tympanum in adults towards the southern part of the total range may be no more than a clinal feature. More information regarding morphology and ecology is needed.

It may be concluded that while there are indubitable similarities between *fenoulheti* and the material collected in Namibia, the Namibian material discussed here as *dombensis*, *damaranus* and *hoeschi* forms a particularly closely knit group as far as external features are concerned, and the differences between this group and *fenoulheti* seem to be contra-indications to Mertens's (1971) combination: *B. dombensis fenoulheti*. In view of this, and also in view of the considerations regarding relationships with *vertebralis* and *kavangensis* sp. n., *fenoulheti* (as here understood) is treated as a discrete species. Hopefully, this position will be tested in the near future by much-needed new morphological, ecological and distributional data.

In the description of *f. fenoulheti* given above, variation in the development of warts and spines was indicated. Development of warts and rosettes of spines tends to be particularly marked in eastern Zimbabwean material (see further under *f. grindleyi*), whereas in the five *vertebralis albiventris* syntypes from Lobatse, only a few of the spines surmounting the larger warts are surrounded by a ring of smaller spines to form rosettes. This conforms with a tendency towards reduction shown in South African material. Nevertheless, the more southern material (including the *fenoulheti* types) by no means falls outside the range of variation shown by more northern material: for example, the Woodbush (Transvaal) *fenoulheti* paratypes show a greater number of rosettes of spines than an AMNH specimen from Kariba Lake, Zambia, which is the northernmost specimen of *fenoulheti* so far collected. Three paratypes of *fenoulheti rhodesianus* in the Natal Museum also have fewer dorsal rosettes (8 to 16) than the Woodbush paratypes (17 to 26). Some variation is shown in eight *fenoulheti obtusum* paratypes from near Rustenburg, Transvaal, but the number of rosettes reaches 16 in one individual—which does not agree with Hewitt's (1932) separation of *rhodesianus* from *obtusum* on the former having 'a greater density of the minute warts and tubercles'. While the *vertebralis albiventris* series may therefore appear to fall somewhat outside the range of variation in the development of dorsal spines and warts shown by Zimbabwean material, the variation of material in the same latitudes in South Africa argues against any need to recognise a separate southern taxon on the basis of this character.

Distribution. Northern Natal, southern Mozambique (excluding coastal lowlands), Transvaal, southeastern Botswana, Zimbabwe (excluding Chimanimani Mountains), extreme southern Zambia.

Localities. BOTSWANA. 65 km NW Francistown (NMZB), Lobatse (MM), Otse (NMZB), Titumi (TM). ZAMBIA. Kariba Lake (AMNH), Victoria Falls (NMZB). MOZAMBIQUE. Belas (NMZB), Comacha (NMZB), Garuso (NMZB), 8 km E Mapulanguene (TM), Matchova (NMZB), 8 km W Tete (NMZB), Vanduzi (NMZB), 24 km SE Vila Manica (NMZB), Zinave (NMZB). ZIMBABWE. 32 km W Birchenough Bridge (BM, NMZB), Burma (West)

(NMZB), 16 km SSW Chakari (AJL), Charara Confluence, Kariba (NMZB), Chido (NMZB), Chibvumani Ruins (NMZB), Chilimanzi (PEM), Chimwara Ranch (NMZB), Chipinda Pools (NMZB), Chitora River (NMZB), Dombashawa Hill (AJL), Dora (BM, NMZB), Driefontein (NM, PEM), 1 km NW Dutchman's Pool (AJL), Fatima (NMZB), Fern Valley (BM, NMZB), Great Zimbabwe (NMZB, TM), Harare (PEM), Harleigh Ruins (NMZB), Imire Farm (NMZB), 8 km SE Kapami (NMZB), Kariba (NMZB), Kariba Tsetse Camp (NMZB), Lekkerwater Ruins (AJL), Lundi River Bridge (NM), Mabalauta (NMZB), Malapati Bridge (NMZB), Maleme Dam (NMZB), Malonga River Bridge (NMZB), Maori Ranch (AJL), Mapembe (NMZB), Mare Dam (NMZB), Matendere Ruins (NMZB), Matopo Mission (NMZB), Matowa (NMZB), Mermaids Pool (NMZB), Mrewa (NMZB), Msoro (NMZB), 11 & 51 km NE Mutoko (NMZB), Ntabambomvu Hills (NMZB), Nyahokwe Ruins (NMZB), Nyaruwenje (NMZB), Punch Rock (NMZB), Ranelia (NMZB), Rowa Division (NMZB), Rusape (PEM), Samalema Gorge (BM, NMZB), Selborne (NMZB), Sinamwenda R.S. (NMZB), Stapleford (NMZB), Udu Dam (NMZB), Vumba Mountain (NMZB), Waganella Farm (AJL), Watsomba (NMZB), Yahokwe (NMZB), Zewa (NMZB).

Bufo fenoulheti grindleyi Poynton

Bufo vertebralis grindleyi Poynton, 1963: 320. Chimanimani Mountains, Zimbabwe. Holotype in the Natural History Museum of Zimbabwe, Bulawayo.

Diagnosis. Female adult size reaching 33 mm. No tarsal fold, subarticular tubercles of fingers usually double, tympanum discernible. Parotid glands tending to be broken up into separate spinose patches; outer margin, when distinct, tending to be more or less straight, not curving markedly downwards behind tympanum. Two to (more usually) 2,5 phalanges of toes 3 and 5 free of web (edge of web may be slightly serrated, making determination somewhat imprecise), broad web between toes 3 and 4 not, to only just, passing base of proximal phalanx of fourth toe. Two palmar tubercles present.

Description. Similar to *f. fenoulheti*, but with following differences. Parotid glands tend to be broken up into spinose patches in specimens from lower altitudes, and become very flattened in specimens from higher altitudes. Outer margin of gland tends to be more or less straight, only rarely showing bulge behind tympanum which is so marked in *fenoulheti*. Width of gland therefore more or less constant along its length. Warts on dorsal skin of males from lower altitudes surmounted by very large, conical, sharp-tipped spine, tending to suppress development of surrounding ring of smaller spines. Warts isolated by smooth skin, and particularly well developed in scapular and sacral area of males, where, characteristically, they are arranged as a pair of paravertebral bands, being absent from middorsal area. The central spine tends to become smaller with increasing altitude, and such spines are not particularly conspicuous in females, where warts carry rosettes which are typical of *fenoulheti*.

Light occipital patch, characteristically conspicuous in *f. fenoulheti*, smaller, and nearly always continuous with light vertebral stripe which nearly always continues onto urostylar area. Light markings therefore take on form of letter Y, made of vertebral stripe continuing into pair of stripes running obliquely over eyelids, with no clearly demarcated occipital patch. On either side of vertebral stripe are more or less paired dark patches. Light sacral patches, usually found in *f. fenoulheti*, lacking.

Irregular dark ventral markings present to greater or lesser degree, irregular midventral stripe and patch at base of each arm being most common, but whole abdominal and pectoral area may become marbled. Markings under arm insertion may be linked to midventral stripe to produce somewhat trident-shaped pattern. This, however, is not as clearly marked as trident pattern of *B. taitanus*.

Habitat. Found breeding in shallow pools on gently sloping grass-covered rock faces near the summit of the Chimanimani Mountains.

Remarks. A series of five specimens from Punch Rock, near the Nyanga National Park some 200 km north of the Chimanimanis, shows a tendency for the parotid glands to break up into separate spine-topped clusters as in *grindleyi*, although a marked bulge behind the tympanum, typical of *f. fenoulheti*, is nevertheless evident. All the Punch Rock specimens have some ventral speckling, which is not normally found in *f. fenoulheti*, although the markings are not as well developed as is usual in *grindleyi*. The light sacral patches in the Punch Rock specimens are less conspicuous than are generally seen in eastern *f. fenoulheti*, a condition possibly approaching the lack of development in *grindleyi*; all the Punch Rock specimens show, however, a conspicuous light occipital patch, which is a feature of *f. fenoulheti* but not of *grindleyi*. The single adult Punch Rock male has large, isolated, spine-capped warts on the dorsal skin, but the central spine is not the dominating feature which it tends to be in male *grindleyi*. Other series from the Nyanga area show no, or only a smaller, departure from typical *fenoulheti* than do the Punch Rock specimens; the Nyanga material does however suggest that the Chimanimani material is an extreme manifestation of a tendency in *f. fenoulheti* to undergo some modification in the eastern Zimbabwean highlands. For this reason, *grindleyi* is here given subspecific status. Should the subspecific category be rejected, as is done by Tandy & Keith (1972) (see Introduction), the distinctive features of *grindleyi* would more satisfactorily lead to its being given specific ranking rather than being sunk altogether.

Distribution. Western Chimanimani Mountains of Zimbabwe, from 1 560 m to the summits.

Localities. ZIMBABWE. Western Chimanimani Mountains from 1 560 m (NM, NMZB).

Bufo kavangensis sp. n. Fig. 1

Types. Holotype: a male in the Natural History Museum of Zimbabwe, Bulawayo (NMZB-UM 19074), collected at Khwai River, Botswana, by H. D. Jackson on 8th December 1968. Paratypes: two females (NMZB-UM 19062, 19071) and 24 males (NMZB-UM 19054–61, 19063–19069, 19072, 19074–19080), carrying same data as holotype. NMZB-UM 19070 and 19073 deposited in British Museum (Natural History), London (BMNH 1973.383–384).

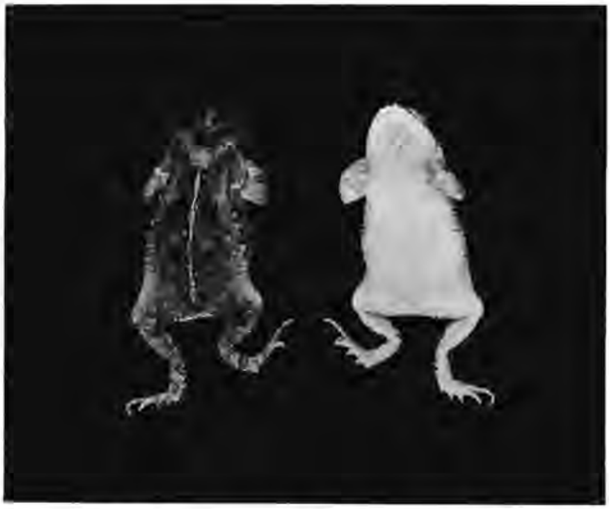

Fig. 1. *Bufo kavangensis* sp. n. Holotype (NMZB 19074).
Natural size: dorsal and ventral aspects.

Dimensions of holotype in mm: snout to urostyle tip 26,5; width of head at gape 9,6; internarial distance 1,7; nostril to eye 2,5; eye to snout tip 3,7; vertical height of tympanum (including ring) as discerned through skin 1,6, horizontal diameter of tympanum 1,2; length of folded tibia 8,7; length of foot (including metatarsal tubercle) 9,3. Paratype female has snout to urostyle tip length of 32,5 mm; paratype males range from 25 mm to 28,6 mm.

Other material. Namibia: 5 males from near Onka (17°35′S:15°58′E) (NMZB-UM 19482–84 & BM 1978.1015–16), 21 juveniles from 32 km W Katwitwi (17°24′S:18°25′E) (TM 38523). Angola: 9 juveniles from 23 km NW Pereira de Eça (17°03′S:15°47′E) (TM 40075). Zimbabwe: 5 males from Hwange National Park (NMZB-UM 26604 & BM 1978.1017–18), 1 juvenile from Main Camp, Hwange N.P. (UM 294), 2 juveniles from Teakland (NMZB-UM 29666–67). It seems likely that three subadults from Runtu (SMF 46497–99) belong to this species, judging from descriptions in Mertens 1955*a* and 1971, but we have not examined this Senckenberg Museum material.

Diagnosis. Female adult size reaching 33 mm. No tarsal fold, subarticular tubercles of fingers usually double, tympanum discernible. Outer edge of parotid gland more or less straight, not extending below level of pupil. One phalanx of toes 3 and 5 free of web (edge of web serrated, making determination imprecise), broad web between toes 3 and 4 reaching about 0,25 to 0,5 way along proximal phalanx of fourth toe. Two enlarged palmar tubercles: large, rounded to triangular-shaped tubercle present below bases of two outer fingers, and smaller, elongated tubercle towards medial surface below base of first finger.

A small-sized *Bufo* with externally discernible tympana, most closely resembling *B. beiranus* Loveridge in overall body shape, in appearance of tympanum, and dorsal markings, but differing from *beiranus* in straight outer (lateral) edge to parotid gland (if evident in *beiranus*, outer edge follows posterior margin of tympanum), fuller webbing (main web between toes 3 and 4 not incised as much as 0,5 along proximal phalanx of toe 3, incised to 0,5 or more in *beiranus*), and lack of ventral skin markings (pigmented patches present in ventral skin of *beiranus*). In addition, in *beiranus* the dorsal warts tend to be surmounted by a rosette of spines, whereas in *kavangensis* the warts are usually surmounted by only a single conical spine, and complete rosettes are hardly ever formed. In body shape also similar to *B. vertebralis* Smith; dorsal markings to some extent resemble those of *vertebralis*, but there is no conspicuous light scapular patch as in *vertebralis* (which could be regarded as a vertebral line that has become shortened to—usually—the scapular region and become intensified). Differing from *vertebralis* in absence of ventral spotting, presence of granular to warty covering of abdominal skin in males (merely wrinkled in *vertebralis*), greater density of spinose warts on dorsal skin (usually entirely lacking on head region of *vertebralis*), and straight outer edge to parotid glands (in *vertebralis* the edge, if evident, follows posterior margin of tympanum).

Resembling *urunguensis* Loveridge in shape of parotid gland and in general body shape (apart from the very distinct, somewhat concave canthus of *urunguensis*), but lacking the dense covering of spinules shown on parotid glands of *urunguensis*, and also lacking the similarly dense covering of spinules on head. Light vertebral line, so conspicuous in *kavangensis*, either very faint or lacking in *urunguensis*, while *kavangensis* lacks ventral marking of *urunguensis*. The species differs in like manner from *B. parkeri* Loveridge (see under *urunguensis*).

The body shape, similar to *vertebralis*, does not present the 'squat' appearance of *B. fenoulheti* and Namibian dwarf toads of the *dombensis* group. Differing from *f. fenoulheti* also in the light dorsal markings, namely possession of vertebral line and lack of the conspicuous light occipital and supra-axillary patches; also differing in the relatively straight outer edge of parotid glands, and more spinose ventral surface, particularly of abdomen of males, and of digits, whose undersurface is densely granular. The more or less straight outer edge to parotid glands in *f. grindleyi* makes *kavangensis* more similar to this form than the nominate form, but light vertebral line of *kavangensis* not comparable to vertebral stripe in *f. grindleyi*, and *kavangensis* lacks the ventral markings of *grindleyi*. Differing from other dwarf toads in Namibia (*dombensis*, *damaranus*, *hoeschi*) in ways discussed under *B. fenoulheti*, notably in possessing straighter outer edge to parotid glands, in much more granular skin, and presence of light vertebral line.

Description. Small-sized toads with particularly granular skins, males reaching length of 30 mm, females reaching 33 mm in the relatively small amount of adult material presently available. Tympanum faintly to moderately discernible, vertical diameter equal or subequal to internarial distance. Parotid glands flattened, separated from upper eyelid only by width of one wart; of constant width (equal to width of upper eyelid) owing to outer margin being more or less straight, not bulging ventrally behind tympanum. Gland with at most sparse covering of minute spines. Subarticular tubercles of fingers and toes usually double, but may be single (although no individual has only single tubercles). Undersurface of digits densely granular. One phalanx (very rarely less than one) of third toe to (more usually) two phalanges free of web on outer surface; a narrow margin of web usually evident along surface of penultimate phalanx, but sometimes merely a serrated line. Edge of web markedly serrated.

Abdominal skin of females a pavement of flattened warts, surmounted by minute spines; males with more prominent warts, each usually surmounted by a single spine. Warts in gular region of female less developed, in males more pronounced and granular in appearance; in pectoral region of males the skin gives, under magnification, the appearance of deeply cracked mud, the surface being a dense packing of flat-topped papillae with minute spines. Skin of back warty, each wart surmounted by spine; only rarely more than one spine per wart and only a limited tendency for a ring of smaller spines to form around each central spine. Top of head without raised warts; only conical spines present, some 25 to 40 in number. Undersurfaces of digits very granular, with dense covering of supernumerary tubercles.

Dorsal markings: light markings may be virtually absent, but usually a conspicuous light vertebral line, generally running from behind occipital area to tip of urostyle; sometimes shorter, rarely longer, in which case it extends into occipital area or onto head. Occipital area may be paler, with oblique projections passing onto each eyelid, but no clear demarcation of light occipital patch which is usually so conspicuous in *fenoulheti*. Characteristic dark markings consist of a usually undivided interocular band, which sometimes has a posterior bifurcation. Rounded dark spot on either side of occipital area present, and behind occipital area a pair of elongated patches, between which frequently arises the light vertebral line. Markings of this region are essentially the same as in *f. fenoulheti*, apart from lack of conspicuous lightening in the central occipital area. Posteriorly, three other pairs of dark patches are usually present: a scapular (which may be continuous with the post-occipital pair), a sacral and a urostylar pair.

Ventral surface lacking pigmented markings. Gular skin of males yellowish in life, with dark vocal sac showing through.

Sexual dimorphism: males in breeding condition may be recognised externally by yellow gular skin and dark vocal sac beneath, by markedly granular ventral skin, and by minute asperities on upper and inner surfaces of first and second fingers and inner palmar tubercle.

Habitat. The type series was collected at ephemeral pools in short grassland on Kalahari Sand following heavy rain. The species enters Zimbabwe on the Kalahari Sands, which appears to be its principal habitat. Breeding probably occurs in pans which are typical of the Sands.

Distribution. Northwestern Zimbabwe, northern Botswana, extreme northern Namibia (but apparently not the western Kaokoveld) and adjoining southern Angola.

Localities. BOTSWANA. Khwai River (NMZB). ZIMBABWE. Hwange N.P. (NMZB), Kazuma Depression (NMZB), Main Camp, Hwange N.P. (NMZB), Teakland (NMZB).

Bufo beiranus Loveridge

Bufo taitanus (not Peters); Boulenger 1907*a*: 480 & 1910: 537, Stevens 1974: 5.
Bufo taitanus beiranus Loveridge, 1932: 45. Beira, Mozambique. Holotype in the British Museum (Natural History), London. Poynton 1964*a*: 67.
Bufo beiranus Loveridge, Grandison 1972: 41.

Diagnosis. Female adult size reaching 28 mm. No tarsal fold, subarticular tubercles of toes usually double, tympanum at least faintly discernible under skin. Parotid glands, when distinct, bulging ventrally behind tympanum, forming a curved outline. Two phalanges of toes 3 and 5 free of web (edge of web serrated, making determination imprecise), broad web between toes 3 and 4 not, to only just, passing base of proximal phalanx of fourth toe. Only one markedly enlarged palmar tubercle, but a tubercle at base of first finger may be slightly larger than other tubercles.

Description. Very small-sized toads with granular skins, males reaching length of 20 mm, females reaching length of 28 mm, becoming gravid at about 21 mm. Tympanum clearly discernible to largely obscured by warts, but ring and columella still present in such cases. Parotid glands fairly distinct to indefinite, tending to be broken into discontinuous patches and obscured by very granular skin; glandular tissue extending ventrally to about half-way behind tympanum, width of backward continuation of gland about 0,6 maximum anterior width. Demarcation of gland from upper eyelid not clear owing to indefinite anterior border, but at least a cleft is present. Subarticular tubercles of fingers and toes usually double (no individual has only single tubercles). Two to (more rarely) 2,5 phalanges of third toe free of web on outer surface, edge of web serrated.

Abdominal skin of both sexes with granular warts, each surmounted by conical spine surrounded by ring of smaller spines. Gular skin of females similar, but gular skin of males more papillate and with fewer spines. Skin of back with slightly raised warts, each of which in females is surmounted by central conical spine surrounded by usually incomplete ring of smaller spines, but not always spined in males. Top of head with spines and no, or less raised, warts. Undersurface of digits very granular.

Dorsal markings: a light vertebral line nearly always present, usually commencing between pair of dark patches placed behind light occipital patch. Vertebral line usually extending to urostyle tip, sometimes extending anteriorly onto head, sometimes not reaching urostyle, or broken in places. Sometimes broader and more pronounced in scapular region, and when restricted to this area strongly recalling pattern of *B. vertebralis*. Light occipital patch may send oblique projections to each eyelid, and sometimes lighter patch in middle of back.

Dark dorsal markings comprise V-shaped to triangular interorbital bar, and paired patches arranged in usual *vertebralis-fenoulheti* manner.

Ventral surface lightly to heavily flecked with greyish freckles, which tend to merge on midline into very irregular streak. Gular region in males tending to be more freckled than in females, and further darkened by heavily pigmented vocal sac.

Sexual dimorphism: males may be recognised by dark vocal sac beneath somewhat more heavily pigmented gular skin, and by presence of minute asperities on at least upper and inner surface of first finger when in breeding condition. Dorsal surface and gular region somewhat less spinose than in females.

Habitat. All the Mozambican material was collected on the alluvial flood plains bordering the Pungwe River, while the Kalabo and Sandaula Plain material comes from the upper Zambezi flood plain.

Remarks. Grandison (1972) noted that *beiranus* 'is incorrectly considered to have affinities with *taitanus*', since the holotype of *beiranus* has middle ear elements, and also differs from *taitanus* in the shape of the parotid glands and in skin texture. Its closest affinities appear to be with *kavangensis* and *vertebralis*, judging by the markings and general build (see under *kavangensis*).

Distribution. Zambezi area of Mozambique and southern Zambia. Presumably occurring in mid-eastern Angola.

Localities. ZAMBIA. Chunga (NMZB), Kalabo (NMZB), Kalomo (BM), Kamilonga Farm (AJL), Kasusu (NMZB), Sandaula Plain (NMZB). MALAŴI. 7 km NW Thuchila (AS). MOZAMBIQUE. Beira (BM), Dondo (NMZB), Muda/Lamego (BM, NMZB), Savane (BM, NMZB), Vila Machado (NMZB).

Bufo urunguensis Loveridge

Bufo urunguensis Loveridge, 1932: 383. Kitungulu, Tanzania. Holotype in the Museum of Comparative Zoology, Harvard. Tandy & Keith 1972: 158.

Diagnosis. Female adult size reaching 29 mm. No tarsal fold, subarticular tubercles of fingers usually double, tympanum clearly discernible under skin. Outer edge of parotid glands more or less straight, not extending below level of pupil. One phalanx of toes 3 and 5 free of web (edge of web serrated, making determination imprecise), broad web between toes 3 and 4 not, to only just, passing base of proximal phalanx of fourth toe. Only one enlarged palmar tubercle.

Description. Small-sized toads, males reaching length of 28 mm, females reaching 29 mm in limited available material. Tympanum clearly discernible, rounded, vertical diameter subequal to internarial distance. Parotid glands flattened, margins not always clearly discernible, separated from upper eyelids by narrow groove. Outer margin, when discernible, more or less straight, width of gland virtually constant along length, width less than width of upper eyelid. Subarticular tubercles of fingers and toes usually double; no individual has only single tubercles. One phalanx of third toe clearly free of web, penultimate phalanx showing variation from moderate webbing to mere trace of web in form of serrations. Edge of web serrated.

Abdominal skin of females granular, minute warts each surmounted by single conical spine; skin of pectoral region with minute spines. Pectoral and gular skin of males more finely granulated and lacking spines. Skin of back with fairly dense scattering of small, conical warts, each surmounted by central spine, only very rarely surmounted by complete rosettes of spines; warts smaller on top of head. Undersurface of digits densely granular.

Dorsal markings in Zambian material very weakly shown, mainly consisting of paler areas on snout, occipital and sacral regions. Ventral surfaces with irregular dark marking concentrated in midventral and pectoral area, very variable in extent. Soles of hands and feet dark.

Sexual dimorphism: in males vocal sac weakly shown through thick gular skin. Ventral skin in males lacks spines; in breeding condition, minute asperities present on upper and inner surfaces of first and second fingers.

Habitat. Apparently restricted to forest and woodland.

Remarks. Only five specimens of this species have been collected in Zambia, and the three BM Kalambo Falls specimens are in a very poor state of preservation. The above description therefore rests partly on examination of extralimital material, including a BM paratype. The species shows marked similarities with *B. parkeri* Loveridge, as has been pointed out to us by Grandison (in litt. 1981, 1982). The life history deserves investigation as a source of information regarding affinities.

Distribution. Tanzania and Zambia in the region of southeastern Lake Tanganyika.

Localities. ZAMBIA. Kalambo Falls (BM), Mbala (NMZL).

Bufo taitanus Peters

Bufo taitanus Peters, 1878: 208. 'Taita', Kenya. Syntypes in the Zoologisches Museum, Berlin, and the Museum of Comparative Zoology, Harvard. Grandison 1972: 38, Tandy & Keith 1972: 156 (part).
Bufo taitanus taitanus Peters, Loveridge 1953: 339, Poynton 1964*b*: 199, Stewart 1967: 36, Broadley 1971: 110.

Diagnosis. Female adult size reaching 33 mm. No tarsal fold, subarticular tubercles of fingers and toes usually double, no vocal or auditory apparatus. Outer edge of parotid gland more or less straight, not extending below level of pupil. One to 1,5 phalanges of toes 3 and 5 free of web (edge of web serrated, making determination imprecise), broad web between toes 3 and 4 reaching 0,25 to 0,5 way along proximal phalanx of fourth toe. Only one enlarged palmar tubercle; tubercle at base of first finger not conspicuously larger than other palmar tubercles.

Description. Small-sized toads, males reaching length of 27 mm, maturing at about 19 mm, females reaching a length of 33 mm, becoming gravid at about 23 mm; apparently attaining a smaller size on Nyika Plateau, three fully gravid females from the Zambian side (AMNH, NMZB) ranging in snout-urostyle length from 22 to 23 mm, while a gravid NM female from Chelinda has a length of only 20,5 mm. No sign of tympanum. Parotid glands distinct, although usually continuous with upper eyelid and at most demarcated anteriorly by crease in adults, although more widely separated in juveniles. Outer edge of gland more or less straight, sometimes slightly bulging ventrally behind otic region, but in most cases keeping to a line at or slightly above level of angle of eye. Width of gland not greater than width of upper eyelid. One to 1,5 phalanges of third toe free of web on outer surface, edge of web serrated.

Abdominal skin of female granular, with closely set warts each surmounted by rosette of spines; granules finer but even more prominent on pectoral and gular surfaces. Ventral skin of males smoother, particularly in gular area. Skin of back in females with scattered warts, each surmounted by a subconical spine, which is sometimes surrounded by an incomplete ring of smaller spines. Occasional spines without raised base also occur, notably on head. Dorsal surface of males has fewer, smooth warts, and no spines on top of head. Undersurface of digits densely granular.

Dorsal markings: middorsal areas tend to be lighter in colour; dark markings consist of interocular bar, usually V-shaped, and paired markings posteriorly which tend to disintegrate in larger specimens. Elongated markings, which may join middorsally, usual in occipital and scapular regions, and usually a transverse sacral bar forming an inverted V.

Ventral markings: trident-shaped dark pattern characteristic, central prong being formed by forwardly tapering pectoral patch, and side prongs formed by patches projecting forwards from base of each arm and connecting posteriorly with pectoral patch. Vermiculation or marbling present to a greater to lesser extent on abdominal region.

Sexual dimorphism: males have much smoother skins, the difference being particularly marked in gular region. Males in breeding condition develop minute dark asperities over most of first finger and inner surface of second finger.

Habitat. Evidently a widely tolerant species; reported collecting sites range from forest to a ploughed area in open grassland (Stewart 1967). Emergence occurs probably only with heavy rain, and Stewart (1967: 38) remarks that these toads 'are probably widespread but rarely seen'. A long series from Lilongwe was taken from an open trench through the site for the new capital city following heavy rain.

Distribution. Malaŵi, northern Zambia, southern Zaïre through to Kenya.

Localities. ZAMBIA. Chipangali (NMZB), Kalambo Falls (BM), Nchanga (BM), Nyika Plateau (AMNH, NMZB). MALAŴI. nr Bolero (USNM), Chelinda (NM), Chikangawa (USNM), Dedza (USNM), 6 km E Katumbi (CAS), Kazuni Estate (BM), Lilongwe (BM, NMZB), Nkonjera Mountain (NMZB), Rumpi (USNM). MOZAMBIQUE. Chifumbazi (Loveridge 1953*a*).

Bufo lonnbergi Andersson

Bufo lönnbergi Andersson, 1911: 35. Mount Kenya. Syntypes in the British Museum (Natural History), London, the Museum of Comparative Zoology, Harvard, and the Naturhistorika Rijkmuseet, Roslagsvägen. Martin 1972: 63, Tandy & Keith 1972: 156.

Bufo taitanus nyikae Loveridge, 1932: 339, Poynton 1964*b*: 199, Stewart & Wilson 1966: 298, Stewart 1967: 38, Broadley 1971: 111.

Bufo loennbergi; Grandison 1972: 31.

Bufo lonnbergi; Frost 1986: 52.

Diagnosis. Female adult size reaching 44 mm. No tarsal fold, subarticular tubercles of fingers and toes usually double, no auditory apparatus. Outer edge of parotid gland more or less straight, not extending below level of pupil. Two phalanges of toes 3 and 5 free of web (a tendency towards serration of web edge can make determination uncertain), broad web between toes 3 and 4 not, to only just, passing base of proximal phalanx of fourth toe. Two enlarged palmar tubercles, tubercle at base of thumb being elongated and slightly larger than remaining palmar tubercles.

Description. Medium-sized toads, males reaching length of 38 mm but maturing by 26 mm or possibly less, females reaching length of 44 mm. No sign of tympanum. Parotid glands distinct, although (at least in Malaŵian material) tending to be fully continuous with glands on eyelids; outer edge more or less straight, not descending below level of angle of eye, or slightly bulging ventrally behind otic region. Two to 2,5 phalanges of third toe free of web on outer surface, edge of web not, to moderately, serrated.

Abdominal skin of females granular, having dense covering of warts each surmounted by single small spine or by minute rosettes. Undersurface of males lacking spines, and warts more flattened. Skin of back in females with low warts surmounted by small spines which form more or less complete rosettes on bigger warts; fairly dense scattering of spines on top of head. Dorsal skin of males with very low warts which usually lack spines. Undersurfaces of digits with rounded, smooth tubercles.

Dorsal markings: female with paired dark patches, tending to be elongated in scapular region. Males have at most only indications of these markings, and overall a light brown colour. Faint, whitish vertebral line usually present in both sexes.

Ventral markings vary from few grey flecks to usually faint, irregular midventral band, tapering anteriorly, and patches at base of each arm. In juveniles dark areas usually more clearly marked, but full trident pattern of *B. taitanus* not developed.

Sexual dimorphism: skin of males much less spiny and warty than skin of females, and males tend to lack dorsal markings (Stewart 1967 pl. 2). Males in breeding condition have minute brown asperities over most of surface of first finger and inner surface of second, and on inner palmar tubercle.

Habitat. Associated mainly with forest: Stewart (1967: 40) reports the toads on the Nyika Plateau 'in or near wet boggy *dambos* on the grassland, but never at great distances from trees'. According to Tandy & Keith (1972), males emit a mating call in breeding aggregations, despite a lack of otic structures.

Distribution. Nyika Plateau of Malaŵi and Zambia, and Kenyan highlands. Not recorded from intervening areas.

Localities. MALAŴI and ZAMBIA. Nyika Plateau (AMNH, BM, MCZ, NMZB).

Bufo lindneri Mertens

Bufo lindneri Mertens, 1955*b*: 48. Dar-es-Salaam, Tanzania. Holotype in the Staatliches Museum für Naturkunde, Stuttgart.
Bufo taitanus beiranus (not Loveridge); Poynton 1966: 15.
Bufo incertae sedis, Grandison, 1972: 43.
Bufo sp. Stevens, 1974: 6.

Diagnosis. Female adult size reaching 32 mm. No tarsal fold, subarticular tubercles of fingers and toes double, no auditory apparatus. Parotid gland flattened, bulging ventrally behind otic region, forming strongly curved outline. Two phalanges of third toe free of web (edge of web very serrated, making determination imprecise), broad web between toes 3 and 4 just passing base of proximal phalanx of fourth toe. Two enlarged palmar tubercles, the one at base of first finger being larger than remaining palmar tubercles.

Description (based partly on extralimital material). Small-sized toads, males reaching a length of 22 mm in limited material available, females reaching length of 32 mm. No sign of tympanum. Parotid glands flattened, separated from upper eyelids by distinct cleft. Outer margin bulging behind otic region, width of backward continuation of gland 0,65 to 0,72 maximum anterior width, surface smooth although minute spines present. Subarticular tubercles of fingers and toes double. Two phalanges of third toe free of web on outer surface, edge of web serrated.

Abdominal and pectoral skin of females granular, composed of warts each surmounted by single small spine or by minute rosettes; gular region smoother. Abdominal and pectoral skin of male granular; gular region very smooth. Skin of back with very small, flattened warts in females, each surmounted by minute single spine; no rosettes of spines. Top of head without distinct warts; minute spines present in females but not males. Undersurface of digits densely granular.

Dorsal markings: dark markings consist of paired patches, the densest being a small pair of posteriorly diverging markings behind occipital area, which may meet middorsally or may be well separated. No complete interorbital bar, although ocular markings present. Area between post-occipital pair of markings usually light-coloured: this area may be conspicuous and may continue backwards as light vertebral stripe. Ventral markings: broad midventral dark band present, terminating anteriorly in well-marked point in pectoral to gular region.

Sexual dimorphism: males have smoother gular region, and in breeding condition develop minute asperities over most of first finger and inner surface of second.

Habitat. The specimen from 19 km S of Erego was taken in leaf litter by a small stream in woodland; the toads from Mitucué Mountain and Nova Freixo were on granite outcrops following rain. Stevens's Thuchila specimen was found in a maize garden in pouring rain (pers. comm.). Tanzanian material in the BM collected by K. M. Howell was also collected after heavy rain (Howell 1979).

Remarks. Clarke (in press) found that the Tanzanian specimens identified as *B. lindneri* by Grandison around 1978 agree with material listed by her as *B. incertae sedis* (1972). One of us (J.C.P.) has been able to study the material and to confirm Clarke's identification.

Distribution. Northern Mozambique, southern Malaŵi, Tanzania.

Localities. MALAŴI. 7 km NW Thuchila (AS). MOZAMBIQUE. 19 km S Erego (NMZB), Mitucué Mountain (NMZB), Nova Freixo (NMZB).

Bufo melanopleura Schmidt & Inger

Bufo melanopleura Schmidt & Inger, 1959: 23. Kankunde River, Upemba National Park, Zaïre. Holotype in the Musée Royale de l'Afrique Centrale, Tervuren. Tandy & Keith 1972: 156.

Diagnosis. Female adult size reaching 27 mm. No tarsal fold, subarticular tubercles of fingers and toes usually double, no vocal or auditory apparatus. Outer edge of parotid gland more or less straight (rarely a slight bulge behind the otic region). One phalanx (? in Zambia) to two phalanges (in Zaïre) of toes 3 and 5 free of web (edge of web serrated, making determination imprecise), broad web between toes 3 and 4 reaching about 0,25 way along proximal phalanx of fourth toe. Only one enlarged palmar tubercle.

Description (based partly on extralimital material). Very small-sized toads, males reaching length of 22 mm, females 27 mm. No sign of tympanum. Parotid glands flattened, distinct at least on outer surface, running level with pupil, except in some specimens where there is a slight downward bulge behind otic region. Glands abutting anteriorly onto eyelids, separated at most by narrow cleft. Width of gland less than width of upper eyelid. One to 2 phalanges of third toe free of web on outer surface, edge of web serrated.

Abdominal skin of female granular, with closely set warts, each surmounted by minute rosette of spines; spines less developed to absent in gular region. Ventral surface of males smoother. Skin of back in females with small, rounded warts, each surmounted by light-coloured, subconical spine, giving pustular appearance. These may be reduced on top of head, but not on upper eyelids or on parotid glands. Males with less developed warts, but light-coloured spines as conspicuous as in females. Undersurface of digits densely granular.

Dorsal markings: virtually lacking to showing poorly defined pairs of longitudinal, oblique or transverse bars. Pair of light patches may be present on sacral area. Sides of body usually darker brown. Ventral markings: dark midventral patch, tapering anteriorly, which may cover only narrow medial strip or may cover most of ventral surface and join forwardly projecting patch under each arm, recalling trident pattern of *B. taitanus*.

Sexual dimorphism: skin of males is smoother than of females, and males in breeding condition have asperities on two inner fingers.

Habitat. Apparently showing a preference for forest or woodland.

Remarks. The above description is based largely on Upemba Park material. Only one specimen has been collected outside this area, this being a NMZB Bwana Mkubwa specimen from south of Ndola. This specimen, a female, is 1 mm larger than the largest Upemba specimen, and has particularly well developed webbing and ventral coloration.

Schmidt & Inger (1959) report relatively large eggs (1,8 to 2,0 mm in diameter) in this species. The number of ova in the gravid female is correspondingly small: up to 35. The breeding biology and life history of the species needs investigating, particularly as it might have a bearing on the generic placing of the species.

Distribution. Southern Zaïre and northwestern Zambia.

Locality. ZAMBIA. Bwana Mkubwa, south of Ndola (NMZB).

Genus *Stephopaedes* Channing

Stephopaedes Channing, 1978: 394. Type by monotypy: *Bufo anotis* Boulenger, 1907*d*: 48.

The status of this genus is discussed in the introduction. The genus features large eggs, and peculiar tadpoles which are adapted for living in pools contained in buttress roots. Two taxa appear to be recognisable (see Remarks under *S. anotis*).

Stephopaedes anotis (Boulenger)

Bufo anotis Boulenger, 1907*d*: 48. Chirinda Forest, Zimbabwe. Syntypes in the British Museum (Natural History), London, Boulenger 1910: 536, FitzSimons 1939: 39, Poynton 1964*a*: 68, Tandy & Keith 1972: 133, 156.
Stephopaedes anotis (Boulenger), Channing 1978: 394.

Diagnosis. Female adult size reaching 45 mm. No tarsal fold, subarticular tubercles of fingers and toes double, tympanum absent. Parotid glands very broad and flattened, considerably wider than width of upper eyelid, extending ventrally to level of upper jaw; flattened or planed lateral and dorsal surfaces set at a clear angle of nearly 90° to each other. One phalanx of toes 3 and 5 free of main webbing (edge of web very serrated, making determination imprecise especially in large specimens). Two enlarged palmar tubercles present, but inner much smaller and may be only slightly larger than other palmar tubercles.

Description. Medium-sized toads, males reaching length of 38 mm and attaining sexual maturity at length of about 25 mm. In both sexes, opening of vent directed very markedly towards the ventral surface, and lined by deeply folded integument. Cloacal tube also deeply folded. Dorsal skin of females with light-tipped spines (smoother in large specimens) which surmount small, warty bases: larger warts over urostylar area have rosettes of spines, otherwise spines single. Ventral surface with more densely packed spines. Large males lack well-developed dorsal spines and have ventral spines at most only in pectoral region. Skin of both males and females below length of about 32 mm more spinose.

Dorsal markings usually absent: generally dark brown above, sometimes with head and middle of back lighter. Small, irregular but generally paired darker patches may be present, notably a small inverted V or pair of diverging patches in post-occipital area. Fine light vertebral line may be present, when most extensive running from post-occipital marking to above vent. Limbs barred. Ventral surface usually yellowish, with dark freckling mainly over pectoral area. Degree of freckling variable, occasionally reduced to 2 or 3 flecks.

Sexual dimorphism: over a size of about 32 mm, males have smoother skins than females. Males have asperities developed on inner and upper surfaces of inner two fingers, and also occasionally over inner palmar tubercle.

Habitat. This species occurs in the leaflitter of lowland evergreen forest, often hiding inside or beneath rotten logs. The eggs are laid in pockets of water between the buttress roots of forest trees (*Chrysophyllum gorungosanum*), or in water-filled grooves which are occasionally found on the horizontal fluted trunks of some fallen trees. The peculiar tadpole is illustrated by Channing (1978).

Remarks. Poynton (1977) listed material from southern Tanzania as *B. anotis*, while noting differences between the Tanzanian and Zimbabwean collections. This material is to be described as a separate taxon (Poynton in prep.), and is consequently not included below under Distribution.

The downwardly directed cloacal opening of *anotis*, and its deeply folded integument, suggest a specialised mode of fertilisation. This needs to be investigated. The cloacal anatomy resembles that of *Mertensophryne micranotis*, described by Grandison (1980*a*).

Distribution. Southeastern Zimbabwe and adjoining Mozambique.

Localities. MOZAMBIQUE. Dombe Forest (NMZB). ZIMBABWE. Chirinda Forest (BM, NM, NMZB, TM).

Genus *Schismaderma* Smith

Schismaderma Smith, 1849 App.: 28. Type by monotypy: *S. lateralis* Smith, 1849 (substitute name for *Bufo carens* Smith, 1848).

A monotypic genus according to current assessment. Its relationships are discussed in the introduction.

Schismaderma carens (Smith)

Bufo carens Smith, 1848: 68. 'Interior of Southern Africa'. Syntypes in the British Museum (Natural History), London. Boulenger 1907*a*: 480 & 1907*b*: 4 & 1910: 537, Power 1927: 418, Pitman 1934: 310, FitzSimons 1935: 382 & 1937: 270, Loveridge 1933: 355 & 1953*a*: 377 & 1953*b*: 141, Hoffman 1944: 174, Poynton 1964*a*: 60 & 1964*b*: 198, Stewart 1967: 33, Broadley 1971: 110, Tandy & Keith 1972: 158, Stevens 1974: 5, Simbotwe & Patterson 1983: 21.

Schismaderma lateralis Smith, 1849 app. p. 28 (new name for *Bufo carens* Smith).

Schismaderma carens (Smith), Günther 1858: 138, Tandy & Tandy 1976: 354.

Diagnosis. Female adult size reaching 86 mm. Tarsal fold present, subarticular tubercles of fingers single to bifid to almost double; subarticular tubercles under toes single. Tympanum very clearly discernible. No parotid glands; instead glandular ridge extends from above tympanum laterally to near leg insertion. Two or fractionally more phalanges of toes 3 and 5 free of main webbing; a usually well-developed margin of web reaching distal phalanges.

Description. Fairly large-sized toads, with generally lighter pinkish or red coloured dorsal surface clearly demarcated from ventral surface at lateral glandular ridge. Pair of dark, usually rounded markings characteristically present in sacral region, and lighter marking present at least in juveniles, composed of an inverted triangle with its base running between eyes, from apex of which arise two oblique, irregular bands terminating lateral to pair of sacral spots. These markings may be disrupted and only faintly indicated even in juveniles, and become less evident or lost in adults (except rarely where sections of markings become as darkened as sacral spots).

Chest and abdomen speckled grey or black, and in males gular region suffused with black.

Habitat. Widespread in savannas. It favours deep pools or dams for breeding, and calling is done while the males are floating. The tadpoles congregate in compact swarms in deep water, and have a horseshoe-shaped dorsal fold that has a respiratory function (Charter & MacMurray 1939). This is the only large-sized toad commonly found in caves and mine adits.

Distribution. From the northern Cape Province and southern Natal (South Africa) northwards through savannas to southeastern Zaïre and Tanzania, but avoiding the Beira-Lower Zambezi area (cf *Bufo garmani*).

Localities. BOTSWANA. Francistown (TM), Kanye (TM), Kasane (NMZB), Metsimaklaba River (TM), Otse (NMZB). CAPRIVI. Katima Mulilo (TM). ZAMBIA. Balmoral Farm (NMZB), Chongola (BM), Chikoa (NMZB), Chipata (NMZB), Chipongwe (NMZB), 16 km W Chisamba (AJL), Chunga (NMZB), Gwembe Valley (NMZB), Kabwe (BM), Kalabo (NMZB), Kalomo (BM), Kasusu (NMZB), Katete/Lupande (NMZB), Kazungula (NMZB), Livingstone (NMZL), 8 km E Lusaka (BM), Mazabuka (NMZB), Mfuwe (NMZB), Mkanda (NMZB), Monze (NMZL), Ndola (NMZB), Nkala (NMZB), Nkana (MM), Siantamba (NMZB), Zongwe River (BM). Ikomba (Loveridge 1933). MALAŴI. Mzimba (BM), Salima (NMB). Chitala; Mangoche; Mzimba (Loveridge 1953*a*). 'Nchalu' (?Nchalo) (Loveridge 1953*b*). nr Lake Kazuni; Mwanda Mountain; Rumpi; Vwaza Marsh (Stewart 1967). MOZAMBIQUE. Coguno (BM), Estatuane & 6 km S (NMZB), Gumba (NMZB), 15 km SW Magude (TM), 8 km E Mapulanguene (TM), Mazamba (TM), Moamba (TM), Nhamacala (NMZB), Vila Machado (NMZB). ZIMBABWE. Antelope (NM), Atlantica E.R.S. (AJL), Bembezi (NMZB), Buffalo Range (NMZB), Bulawayo & 26 km NW (NMZB), Cement (NMZB), Charara Confluence (NMZB), Chinhoyi (NMZB), Chilimanzi (PEM), Chiredzi (BM, NMZB), Chizarira N.P. (NMZB), Criterion Mine (NMZB), Crombies Station (BM), Danangombe Ruins (NMZB), Dete (NMZB), Esigodini (NMZB), Falcon College (AJL), Feruka (BM, NMZB), Gokwe (TM), Gokwe/Sanyati C.H.A. (NMZB), Great Zimbabwe (NMZB), Gweru (NMZB), Harare (AJL, NMZB), Heany (NMZB), Hwange (NMZB), Inyati C.L. (NMZB), Jalopi River (NMZB), Kadoma (AJL), Kame Ruins (NMZB), Kapami & 8 & 16 km SE (NMZB), Karoi (NMZB), Kazungula (NMZB), Kwekwe (AJL, NMZB), Linslade Farm (NMZB), Lonely Mine (NMZB), Lundi River Bridge (NM), Lusulu (NMZB), Mahenya (NMZB), Maleme Dam (NMZB), Masvingo (NMZB), Mkonono Estate (AJL), Mount Hampden (NMZB), Mutare (NM, NMZB), Mzarabani C.L. (NMZB), Ntambambomvu Hills (NMZB), 16 km NW Nyamandhlovu (NMZB), Old Umtali (NMZB), Rhodes Estate Prep. School, Matopos (AJL), Sabi/Lundi Confluence (NMZB), Sengwa Gorge (NMZB), Sengwa West (NMZB), Somabula (NMZB), Thomson Junction (NMZB), 16 km NE Umvuma (NMZB), Main Camp, Hwange N.P. (NMZB), Weirmouth (NMZB).

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GAZETTEER

Note: Localities listed in previous parts (Poynton & Broadley 1985*a*, 1985*b* & 1987) are not re-listed here.

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Chikoa	ZA	1332 A3
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Criterion Mine	ZW	2028 B3
Crocodile Camp	BO	1923 C4
Crombies Station	ZW	2028 B1
Danangombe Ruins	ZW	1929 C4
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Doddieburn Ranch	ZW	2129 A4
Dombe Forest	MO	1933 C4
Dutchman's Pool	ZW	1829 D4
Feruka	ZW	1832 D3
Goonda	MO	1934 C3
Guluene South	ZW	2131 D4
Kalambo Falls	ZA	0831 C1
Kame Ruins	ZW	2028 A2
Katumbi	MA	1033 D3
Kazuni Estate	MA	1133 A4
Kgwebe Hills	BO	2023 C1
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Mazamba	MO	1834 B4
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Munkwi ? = Mkewe	ZA	1031 B4
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Mwenda Estuary	ZW	1727 B2
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